LIBRARY OF CONGRESS
0 018 446 118 3
TS
1578
.V3

VAUGHAN'S CARDING LESSONS

"For the Mill Boy"

BY
M. H. VAUGHAN
HUNTSVILLE, ALA.

1905

THE LIBRARY OF CONGRESS
1800

Class TS 1578
Book V3
Copyright No.

COPYRIGHT DEPOSIT.

Vaughan's Carding Lessons

"For the Mill Boy"

PRICE POSTPAID

$1.25 Per Copy

BY

M. H. VAUGHAN

Huntsville, Ala.

1905

TS1431
.V2

TS1578
.V3

LIBRARY of CONGRESS
Two Copies Received
JUN 13 1905
Copyright Entry
May 18. 1905
CLASS a XXc. No.
117129
COPY B.

Copyright 1905

BY

MATHIS H. VAUGHAN

5-19052

CONTENTS

PREFACE

After writing for several years for different textile papers on calculations in the carding room, I have written a series of articles on calculations for the mill boy whose educational facilities are limited. Knowing the value of such information from my own experience as a mill boy I have decided to put them in book form.

I have made every effort to make this work so simple that with a knowledge of the four ground rules of arithmetic most all of the problems can be solved. The repetition of the draft and the twist constant is intended to make them more simple for the learner.

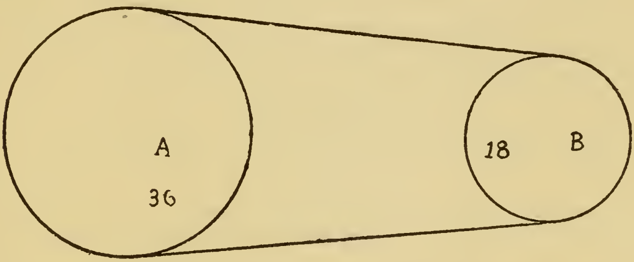
M. H. VAUGHAN

Huntsville, Ala., Oct. 31, 1904.

CHAPTER I.

The first principles in mechanical arithmetic as applied to belts and pulleys.

In the figure given below, A represents a pulley on the main line of shafting, B is a pulley on the countershaft. A is 36 inches in diameter, B is 18. If the pulley A makes 250 revolutions per minute, how many revolutions will B make?



A boy in his first conception of figuring speed of pulleys is naturally inclined to the idea that the circumference of the pulley A should be multiplied by its revolutions, and this product divided by the circumference of the counter pulley B. This would give the revolutions correctly, but for practical purposes we take the diameter instead of the circumference. Multiply the diameter of A, which is 36 inches, by 250 revolutions of A.

$$36 \times 250 = 9000.$$

Divide this product by the diameter of B, which is 18 inches.

$$9000 \div 18 = 500.$$

revolutions of the counter pulley. Putting B on main line and A on the counter will make B the driver and A the driven. Then if B makes 250 revolutions, what will A make per minute? Multiply diameter of B by the revolutions of main shaft.

$$250 \times 18 = 4500.$$

Divide this product by 36, the diameter of A,

$$4500 \div 36 = 125,$$

the revolutions of the counter shaft.

If we have a pulley on main shaft 36 inches in diameter making 250 revolutions per minute and wish the counter shaft to make 400 revolutions per minute, what diameter of pulley will be required on the counter shaft? Multiply revolutions of main shaft by the diameter, 36 inches.

$$250 \times 36 = 9000.$$

Divide this product by the revolutions we wish the counter shaft to make per minute,

$$9000 \div 400 = 22.5$$

diameter in inches of the pulley required. If we have a pulley 30 inches in diameter on the counter shaft which we wish to make 160 revolutions per minute, what diameter of pulley will be required on the main line, which makes 250 revolutions per minute? Multiply the revolutions of the counter shaft by the diameter of the pulley,

$$30 \times 160 = 4800.$$

Divide this product by the revolutions of main shaft,

$$4800 \div 250 = 19.2,$$

diameter in inches of the pulley required on main line. If the 36 inch pulley on main shaft makes 250 revolutions per minute, how many feet will the belt travel in the same time? In this case we shall have to get the circumference of the 36 inch diameter pulley. The rule for this is to multiply the diameter of the pulley by 3.1416, which is the constant for figuring the circumference by the diameter and has four figures to the right hand of the decimal point. We get the circumferance as follows: Multiply

$$3.1416 \times 36 = 113.0976$$

inches around the pulley. Multiply this product by the revolutions per minute of the pulley,

$$250 \times 113.0976 = 28274.4$$

inches of travel; divide this product by 12 and the quotient will be feet.

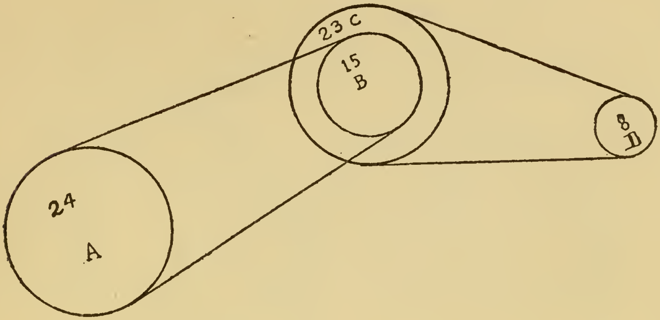
$$28274.4 \div 12 = 2356.2.$$

Knowing the circumference of a pulley we find the diameter by dividing by the 3.1416. Take the circumference.

$$113.0976 \div 3.1416 = 36$$

inches in diameter.

Now add two more pulleys to the first. In the following example A is on the main line of shafting, B and C are on the same counter shaft and D is on a counter shaft. A and C are drivers, B and D are driven. A is 24, B is 15, C 23



and D 8 inches in diameter. If A makes 250 revolutions per minute, what will D make in the same time? To show the principle of figuring this example, we will work it by the single rule of three. Multiply A by the revolutions of main line,

$$250 \times 24 = 6000.$$

divide this product by B,

$$6000 \div 15 = 400.$$

revolutions counter shaft. Multiply this by the pulley C, which is 23 inches in diameter,

$$400 \times 23 = 9200.$$

Divide by the pulley D, 8 inches in diameter,

$$9200 \div 8 = 1150,$$

revolutions of pulley D per minute.

The rule for these examples is, multiply the revolutions of main shaft per minute and all the drivers together for a dividend and all of the driven for a divisor, as follows: $250 \times 24 \times 23 = 138000$, then $15 \times 8 = 120$, and $138000 \div 120 = 1150$ revolutions of pulley D.

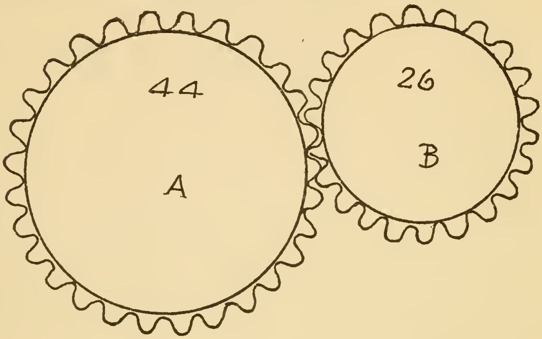
Then the statement should be:

$$\frac{250 \times 24 \times 23}{15 \times 8} = 1150.$$

CHAPTER II.

The first principles in mechanical arithmetic as applied to gears and worm gears.

A is a gear wheel on a shaft making 160 revolutions per minute and has 44 teeth, and B has 26 teeth.



How many revolutions will B make in the same time? A is a driver and B a driven. Multiply the number of teeth in A by the revolutions and divide this product by the number of teeth in B.

160×44=7040. 7040÷26=270.76 revolutions per minute of B.

If B is a driver and makes 250 revolutions per minute, what will A make? Multiply B by its revolutions and divide this product by A.

250×26=6500. 6500÷44=147.72, revolutions of gear A.

If A makes 175 revolutions per minute and has 44 teeth and we wish to make 220 revolutions in the same time, how many teeth will be required in B?

175×44=7700. Divide this by revolutions of B. 7700÷220=35 teeth required in B.

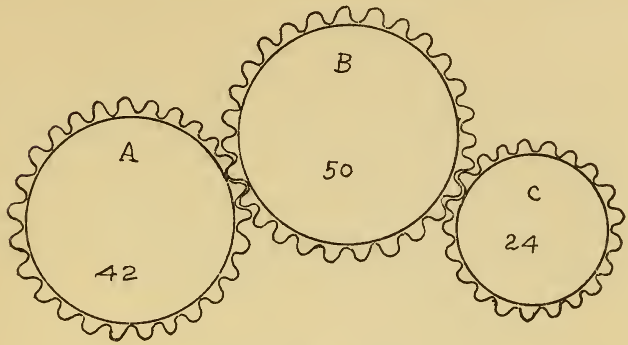
Gear wheels are figured the same as pulleys, except we take the number of teeth instead of the diameter.

In the next train of gears, intermediate or carrier gears like B that merely transmit the power from A to C are not considered in figuring the speed.

If A makes 150 revolutions per minute, what will C make in the same time? Multiply the number of teeth in A by its revolutions.

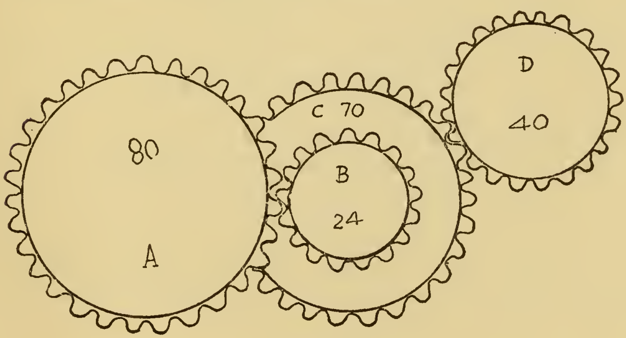
150×42=6300. Divide this product by teeth in C. 6300÷24=262.5, revolutions of C.

If C makes 180 revolutions per minute, what will A make?



180×24=4320. 4320÷42=102.85.

Will now add two more gears to the first example. If the power is applied to A, A and C are drivers and B and D are driven, but if the power is applied to D then D and B are drivers and C and A are driven.



A is a driver and makes 250 revolutions per minute, what will D make in the same time? Mutliply the number of teeth in all of the drivers, together with the revolutions of A for a dividend.

200×80×70=1120000.

Multiply the number of teeth in all of the driven together for a divisor,

40×24=960.

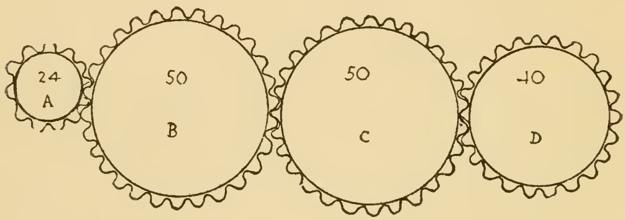
then divide the product of the drivers by the driven.

$$1120000 \div 960 = 1166.66$$

revolutions of D per minute. This example should be stated and worked out as follows:

$$\frac{200 \times 80 \times 70}{40 \times 24} = 1166.66.$$

We sometimes have an example to work out like the following. In this case A is a driver, B and C are intermediate carriers used to transmit the power from A to D and are not taken into account in figuring the speed of D from A; and in this example we only take the number of teeth in D as follows: A is a driver and makes 175 revolutions per minute. What will D make in the same time?



$$\frac{175 \times 24}{40} = 105 \text{ revolutions of D.}$$

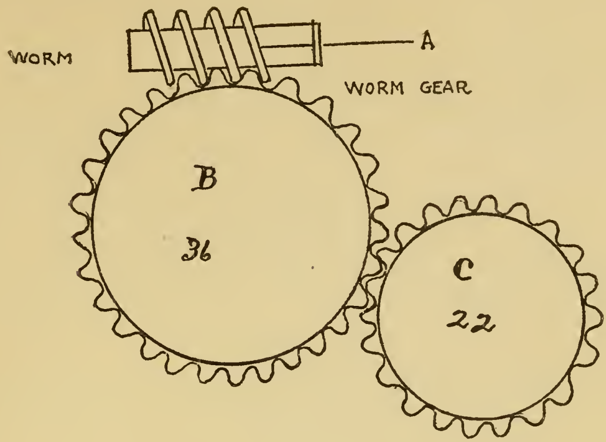
We will make D a driver which will make 120 revolutions per minute. What will A make in the same time?

$$\frac{120 \times 40}{24} = 200 \text{ revolutiona of A.}$$

If A has 24 teeth and makes 240 revolutions per minute and we wish D to make 180 in the same time, how many teeth will be required in D?

$$\frac{240 \times 24}{180} = 32.$$

It happens frequently that we have worm gears to figure. A is a worm, B the worm gear and C is a counter gear. If A makes 308 revolutions per minute, what will C make? In the statement of this example, if the worm is single threaded put 1 in its place, or if double put 2 in its place. In this example the worm is single.



$$\frac{308 \times 1}{22} = 14, \text{ revolutions of C.}$$

If A makes 440 revolutions per minute, what will B make?

$$\frac{440 \times 1}{36} = 15, \text{ revolutions of B.}$$

If A is double threaded and makes 216 revolutions per minute, what will B make?

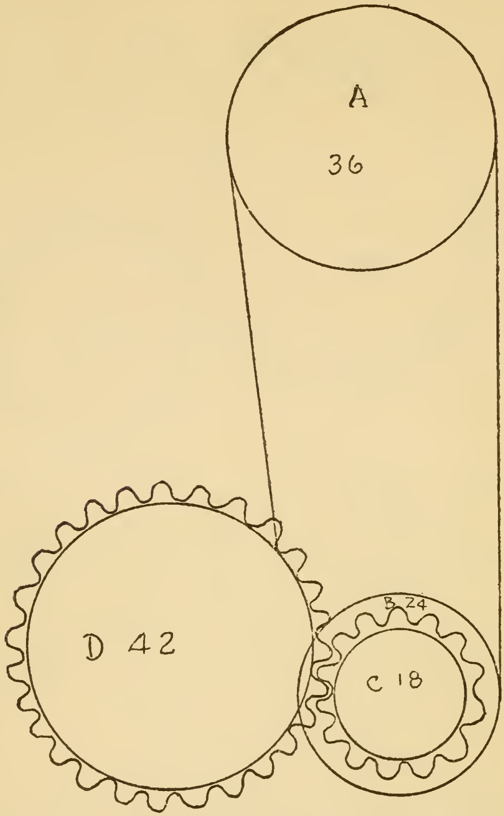
$$\frac{216 \times 2}{36} = 12, \text{ revolutions of B.}$$

The rule is, divide the revolutions of the worm, if single-threaded, by the number of teeth in the worm gear. If double, multiply the revolutions of the worm by 2 and divide this product by the number of teeth in worm gear.

CHAPTER III.

A combination of belts, pulleys and gears.

This example is a combination of belt pulleys and gears. A is a 36-inch diameter pulley on the main line of shafting which revolves 350 times per minute. How many revolutions will gear D with 42 teeth make in the same time?



A is a driver, B is driven 24 inches in diameter, C is a driver with 18 teeth and D is a driven with 42 teeth.

Example: $$\frac{350\times36\times18}{42\times24}=225.$$

Suppose D 42 teeth to be a driver which makes 160 revolutions per minute, what will A make?

Example: $$\frac{160\times42\times24}{36\times18}=248.88.$$

If the line of shafting makes 350 revolutions at A and we wish the gear D to make 180, what diameter of pulley will be required at A? In this case D is a driver, so we put the revolutions of line shaft in place of A in the example, as follows:

$$\frac{180\times42\times24}{350\times18}=28.8.$$

To show the principle of the solution we will solve it by the single rule of three and make D a driver. Multiply the number of teeth in D by its revolutions per minute, which is 180.

$$180\times42=7560.$$

Divide this product by C, which has 18 teeth.

$$7560\div18=420.$$

revolutions of pulley B. Next multiply pulley B, which is 24 inches in diameter, by its revolutions per minute which is 420.

$$420\times24=10080.$$

Divide this product by the revolutions of the line shafting, which is 350.

$$10080\div350=28.8,$$

diameter of pulley required on main line.

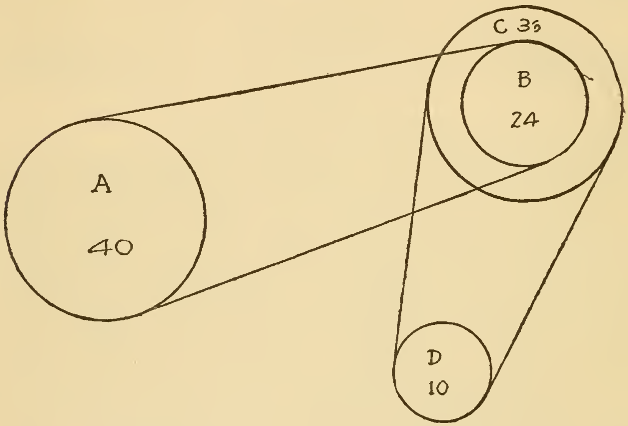
The rule to solve these examples is the double rule of three, and the statement should be made by cause and effect. In the first example in this article pulley A on the main line of shafting is the prime driver, or where the power is first applied. The revolutions of this pulley is a cause, the diameter is a cause and pulley B is an effect. Gear C is a cause and gear D is an effect. If the power is first applied to B and C, then they become drivers and B is a cause and C is a cause, then A is an effcet and so is D. I mention the cause and effect because the learner will more readily understand which terms to place in the dividend and the divisor. In making the statement of the example we should know that all of the drivers are causes and the driven are the effects of the drivers either in a train of belts and pulleys or gears. The revolutions of the main driving pulley is in all cases a cause and so is the diameter of this pulley. And to make the statement more plain will say that the revolutions of A is the first cause, the diameter of A is the second cause and gear C the third cause. Then pulley B will be the first effect and D the second effect. In making the statement draw a horizontal line and place the causes above and effects below the line, thus:

$$\begin{array}{ll}\text{Causes,} & 350\times36\times18 \\ \hline \text{Effects,} & 42\times24\end{array}$$

CHAPTER IV.

Belts and pulleys as applied to line shafting and picker beater pulley.

The three preceding lessons given cover the ground rules for figuring all pulleys and speeds in the mill, and the mill boys who have learned all of the rules and have become familiar with the solution of the examples are now prepared to go with us into the picker room where the next lesson will be given by solving several speed and pulley examples.



A is the driving pulley on main line shaft, which makes 240 revolutions per minute, C and B are on the counter shaft of the picker and D is the beater pulley. The diameter of each pulley is marked in inches. What speed will the beater run?

$$\frac{240 \times 40 \times 36}{24 \times 10} = 1440 \text{ revolutions of beater per minute.}$$

Suppose we wish the beater to make 1,400 revolutions per minute, what diameter of pulley will be required at A?

$$\frac{1400 \times 10 \times 24}{36 \times 240} = 38.88, \text{ diameter of pulley at A.}$$

In this example the beater pulley D becomes a driver. The learner must not become confused because in the first example the beater pulley is a driven and in this one it is a

driver, for if we get the revolutions per minute of the counter shaft on which B and C are fixed, and figure from C to D, C is a driver and D is a driven, or if we figure from B to A, B is a driver and A is a driven. In this case B and C are both drivers.

In the last example we know the revolutions of the beater to be 1,400 and start from this point. Remember that the pulley from which we start to figure the revolutions becomes the first cause and its diameter the second cause, which makes it a driver. It makes no difference whether we figure from the main line or from the beater pulley. For instance, take the first example and find the revolutions of the beater, knowing the main line to make 240 per minute.

$$\frac{240\times40\times36}{24\times10}=1440 \text{ revolutions of beater.}$$

On the other hand, knowing the revolutions of the beater we make it a driver and find the revolutions per minute of the main line.

$$\frac{1440\times10\times24}{36\times40}=240 \text{ revolutions of main line shaft.}$$

On the beater shaft there is a fan pulley 5 inches in diameter, and on the fan shaft is one 8 inches and the line shaft makes 240, what will the fan make per minute?

$$\frac{240\times40\times36\times5}{24\times10\times8}=900.$$

If it is desired to run the beater at 1,200 revolutions per minute instead of 1,440 by making the beater pulley larger, what diameter will be required with the conditions the same as in the first example?

$$\frac{240\times40\times36}{24\times1200}=12 \text{ inches diameter of pulley.}$$

If one picker with a 5-inch diameter feed pulley keeps laps for 11 cards and we add one more card, what diameter of feed pulley will be required for the 12 cards?

$$\frac{5\times12}{11}=5.45 \text{ inches diameter.}$$

If one picker keeps laps for 12 cards with a 6-inch feed

pulley and we wish to cut down the feed so it will keep up for 10 cards, what diameter of feed pulley will be required?

$$\frac{6\times10}{12}=5 \text{ inch feed pulley.}$$

CHAPTER V.

Finding the length of the lap and the draft of the picker.

Will figure the length of the lap from gears on the Kitson picker each having the following number of teeth: Knock-off gear 60, knock-off driver 18, worm gear 35, worm No. 1 calender gear 80, drop shaft gear 13, opposite end of drop shaft 14, large lap roller driver 73, small driver 18, lap roller gear 37, diameter of lap roller 9 inches. Example:

$$\frac{60\times35\times80\times14\times18}{18\times\ 1\times13\times73\times37}=66.98 \text{ revolutions of lap roller.}$$

Multiply this product by the circumference in inches of the 9-inch lap roller, which is 28.27 inches.

$$66.98\times28.27=1893.52.$$

Divide this product by 36 inches and the quotient will be yards in the length.

$$1893.52\div36=52.59$$

In rolling the lap up under the heavy pressure it stretches the lap and it will be longer than it figures. To make up for this we add 4 per cent. to the figured length which will be

$$2.10+52.59=54.69 \text{ yds., length of lap.}$$

If a 60-tooth knock-ff gear gives 54.69 yards, what number will be required to give 48 yards?

$$\frac{60\times48}{54.69}=52.47 \text{ teeth.}$$

Will figure the draft of the picker from the following gears and diameters:

$$\frac{\overset{(1)}{9}\times14\times39\times\overset{(2)}{85}\times\overset{(3)}{3\tfrac{1}{4}}\times54\times30\times14\times14\times\overset{(4)}{18}}{\underset{(5)}{37}\times73\times76\times\underset{(6)}{24}\times40\times\underset{(7)}{10}\times\underset{(8)}{1}\times20\times26\times\underset{(9)}{1.81}}$$

Performing these operations of multiplication and divis-

ion we obtain for a result 4.18 draft.

The figures above and below the fraction are explained as follows:

1. Diameter of lap calender.
2. Worm Gear.
3. Diameter of cone.
4. Feed roller gear.
5. Lap calender gear.
6. Draft gear.
7. Diameter of cone drum.
8. Worm.
9. Diameter of feed Roller.

These gears and diameters are taken direct from the picker as it is made at present. In figuring the draft of any machine, if the feed or back roller and front or lap calender were of the same diameter we should leave them out of the calculation. The learner will get confused as to where to put the diameter of these two rollers in the example. On the picker the front roller is larger than the back and in this case the larger the front and smaller the back roller the more draft it gives. Therefore we put front roller diameter in the dividend and the back roller in the divisor. If the rollers were reversed so as to have the larger one in the back this would make a less draft. Then we should place the diameter of the two rollers in the example the same way as mentioned above, but most machines in the cotton mill have the front roller larger than the back one.

In figuring for the draft constant, we take the above example and leave out the draft gear, which has 24 teeth. A short way to get the draft on the picker is to get the revolutions per minute of the feed and lap calender rollers. Multiply each diameter by its revolutions and divide the larger by the smaller product, as follows: Diameter of feed roller 1.81 inches, revolutions per minute 7, diameter lap calender 9 inches, revolutions 5.89.

$$1.81\times7=12.67. \quad 9\times5.89=53.01.$$

This product. $53.01\div12.67=4.183$, draft.

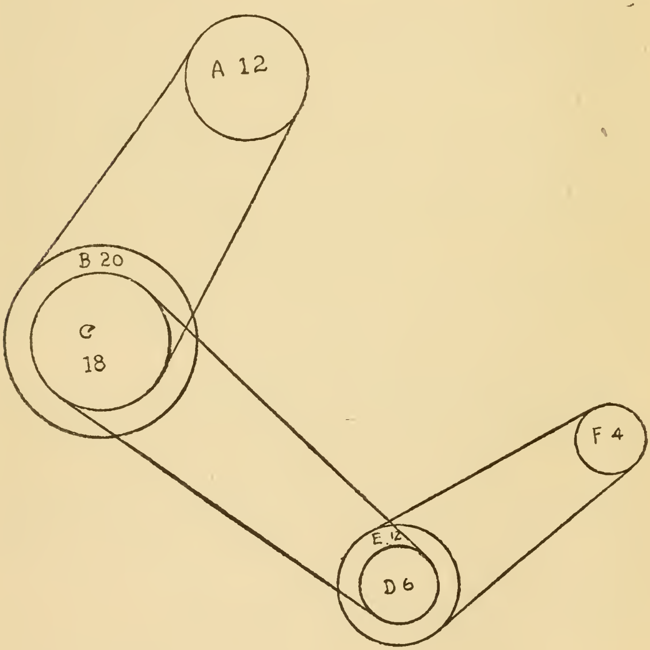
There is another way to get the draft. If there are 4 laps on the feed apron, get the ounces per yard of one, multiply the ounces in one yard by four, and divide by the ounces per yard of the finished lap. Any of these methods are near enough for practical purposes.

CHAPTER VI.

Getting the speed of card comb from the line shafting, also speed of the doffer and licker-in.

A is a pulley on line shaft making 275 revolutions and 12 inches in diameter. B is a pulley 20 inches in diameter on the card cylinder shaft. If line shaft makes 275 revolutions per minute what will the cylinder make in the same time? Example:

$$\frac{275 \times 12}{20} = 165, \text{ revolutions of cylinder.}$$



If A makes 275, what will D make in the same time? Example:

$$\frac{275 \times 12 \times 18}{20 \times 6} = 495, \text{ revolutions of pulley D.}$$

If A makes 275, what will F make in the same time? Example:

$$\frac{275\times12\times18\times12}{20\times6\times4}=1485 \text{ revolutions of F.}$$

A is on the line shaft, B is a pulley on card cylinder shaft, D and E are doffer comb pulleys, and binder F is a comb pulley. In practice where the V-grooved pulleys and the round bands are used, one diameter of the band should be added to the diameter of each pulley as the center of the band governs the speed of the pulleys. Will figure the speed of the doffer from main line from the following pulleys and gears: Line shaft 275 revolutions per minute, diameter of pulley on line shaft 12 inches, pulley on card cylinder 20 inches, licker-in driver on cylinder shaft 18 inches, licker-in pulley 7 inches, barrow pulley driver on licker-in 4 inches, barrow pulley 18 inches, doffer change gear 28 teeth, doffer gear 214 teeth. Example:

$$\frac{275\times12\times18\times4\times23}{20\times7\times18\times214}=12.38$$

Find the constant divisor from the following: Doffer gear 214 teeth, leave out the doffer change gear, barrow pulley 18 inches, small pulley on licker-in 4 inches, large pulley on same 7 inches, cylinder pulley 18 inches, revolutions of cylinder 165. Example:

$$\frac{214\times18\times7}{165\times18\times4}=2.269$$

Dividing the number of teeth in the doffer change gear by 2.269 will give the revolutions of the doffer per minute. How many revolutions per minute will a 28-tooth gear give the doffer? Example:

$$28.000\div2.269=12.33$$

revolutions of the doffer per minute.

If a 28-tooth doffer change gear gives 12.33 revolutions per minute, what will 30 give? Example:

$$\frac{12.33\times30}{28}=13.21 \text{ revolutions of doffer.}$$

If a 30-tooth gear gives 13.21 revolutions per minute, what will 22 teeth give? Example:

$$\frac{13.21\times22}{30}=9.68 \text{ revolutions}$$

If the cylinder makes 165 revolutions per minute and the doffer makes 12 revolutions per minute, how many inches of cylinder surface will pass one inch of doffer surface, the cylinder being 50 inches and doffer 27 inches in diameter? We first get the circumference of cylinder, 157 inches, and doffer, 84.8 inches, and multiply the circumference of each by its revolutions per minute. Cylinder

$$157\times165=25905. \quad \text{Doffer } 12\times84.8=1017.6$$

inches of surface speed. Take surface speed of the doffer from the cylinder,

$$25905-1017.6=24887.4,$$

and divide this product by the surface speed of the doffer,

$$\frac{24887.4}{1017.6}=24.45,$$

the number of inches of cylinder surface that would pass one inch of doffer surface.

If the doffer makes 12 revolutions per minute, what will the feed roller make in the same time with the following gears,—gear on doffer pulley 45 teeth, gear on side shaft doffer end 40, draft gear 20, feed roller gear 120 teeth? Example:

$$\frac{12\times45\times20}{40\times120}=2.25 \text{ revolutions feed}$$

If cylinder makes 165 revolutions per minute, what will the licker-in make in the same time with the following pulleys,—cylinder pulley 18 inches, licker-in pulley 7 inches in diameter?

$$\frac{165\times18}{7}=424.2 \text{ revolutions of licker-in.}$$

With the licker-in making 424.2 and the feed roller 2.25 revolutions per minute, how many inches of licker-in surface will pass one inch of feed roller surface? The licker-in is 9 inches and feed roller 2.25 inches in diameter, circumference of licker-in 28.27 inches, circumference of feed roller 7.06 inches. Multiply each circumference by its revolutions.

Licker-in 28.27×424.2=11992.13 inches of surface. Speed of licker-in 2.25×7.06=15.88 inches of surface speed of roller.

Divide licker-in surface speed by the feed roller speed.

$$\frac{11992.13}{15.88}=755.17.$$

The quotient is the number of inches of licker-in surface that would pass on one inch of stock delivered.

CHAPTER VII.

The draft and draft constant, also production of the card.

Get the draft of the card from the following gears. The card is the Pettee make with the twenty-seven inch diameter doffer, coiled calender roller 2 inches diameter, feed roller bevel gear 120 teeth, gear on side shaft doffer end 40 teeth, doffer gear 214 teeth, gear on card calender roller driver coiler 27 teeth, feed roller diameter 2.25 inches, draft gear 20 teeth, gear on doffer pulley 45, card calender roller gear 21 teeth, gear on coiler upright shaft 17 teeth. Example:

$$\frac{2\times120\times40\times214\times27}{2.25\times20\times45\times21\times17}=76.73 \text{ draft}$$

Get the draft constant with the same conditions as the last example with the draft gear left out

$$\frac{2\times120\times40\times214\times27}{2.25\times X\times45\times21\times17}=1534.56 \text{ draft constant.}$$

Divide the constant by the number of teeth in the draft gear, the quotient will be the draft of the card; or divide the constant by the draft of the card and the quotient will be the number of teeth in the draft gear.

What is the production of the card with doffer making 12 revolutions per minute and the sliver weighing 50 grains per yard? First get the revolutions of the coiler calender roller by the following gears: Revolutions of doffer 12, doffer gear 214, card calender roller 21 teeth, card calender roller that drives coiler 23 teeth, gear on coiler upright shaft 17 teeth, gear on top upright coiler shaft 21 teeth, coiler

calender gear 18 teeth, diameter of coiler calender roller 2 inches. Example:

$$\frac{12\times 214\times 23\times 21}{21\times 17\times 18}=193 \text{ revolutions of}$$

calender roller per minute. The circumferance of the roller is 6.28 inches. Multiply this by the revolutions per minute

$$193\times 6.28=1212$$

inches of sliver delivered per minute. Multiply this by 60 minutes,

$$1212\times 60=72720 \text{ inches in one hour.}$$

Divide this by 36 inches in a yard.

$$72720\div 36=2020 \text{ yards per hour.}$$

Multiply yards per hour by 50 grains sliver.

$$2020\times 50=101{,}000 \text{ grains.}$$

Divide this by 7,000 grains in a pound.

$$101{,}000\div 7000=14.42 \text{ lbs. per hour.}$$

Multiply by 11 hours, $14.42\times 11=158.62$

pounds per day, nothing deducted for stoppage.

A short way to get the production of a card is to multiply the revolutions of the doffer per minute by the weight in grains of one yard of card silver, for the 24 inches diameter of doffer divide by 5.49 and for the 27 inch diameter by 4.57, which will come near enough for all practical purposes. Will take a 24 inch doffer making 12 revolutions per minute with a sliver weighing 60 grains.

$$\frac{12\times 60}{5.45}=131.14 \text{ lbs. per day.}$$

Or take 27 inch doffer making 13 revolutions per minute and a 54 grain sliver.

$$\frac{13\times 54}{4.57}=153.61 \text{ lbs. per day.}$$

If one yard of lap weighs 12 ounces and one yard of doffer sliver weighs 50 grains, what draft has the card? One ounce contains 437.5 grains

$$437.5\times 12=5250 \text{ grains.}$$

Divide by the 50 grains sliver.

$$5250\div 50=105, \text{ draft of card.}$$

There is nothing allowed for waste. If the lap weighs 12

ounces per yard and the draft of the card is 85, what will the sliver weigh in grains?

$$437.5 \times 12 = 5250.$$

Divide this by the draft of the card

$$5250 \div 85 = 61.76.$$

grains per yard of sliver. If the card has a draft of 95 and the card sliver weighs 54 grains, what weight of lap per yard will be required? Multiply the weight of sliver in grains by the card draft and divide by the grains in one ounce.

$$54 \times 95 = 5130.0 \div 437.5 = 11.72 \text{ ozs. per yard of lap.}$$

CHAPTER VIII.

Speed production, draft, and draft constant, with other calculations on the drawing frame.

On the line shaft is a pulley 11 inches in diameter making 280 revolutions per minute, on the main drawing shaft is a pulley sixteen inches in diameter, the pulley on the same shaft that drives the front roller is 16 inches in diameter and on the front roller is a pulley 10 inches in diameter. What speed will the front roller make per minute? Example:

$$\frac{280 \times 11 \times 16}{16 \times 10} = 308.$$

If the front roller makes 308 revolutions per minute, what will the production be per day with 54 grains per yard of drawing sliver? We get the revolutions of coiler calender roller which is two inches in diameter, gear on front roller 20 teeth, coiler shaft 31 teeth, bevel gear on coiler shaft 18 teeth, gear on upright 16 teeth, and the gears on top of upright shaft and coiler calender have the same number of teeth. Example:

$$\frac{208 \times 20 \times 18}{31 \times 16} = 223.5 \text{ revolutions of coiler calender per minute.}$$

The circumferance of calender roll is 6.28 inches. Multiply this by the revolutions.

$$223.5 \times 6.28 = 1403.58 \text{ inches per minute.}$$

Multiply this by 60 minutes.

$$1403.58 \times 60 = 84214.8.$$

Divide this by 36 inches.

$84214.8 \div 36 = 2339.3$ yds. delivered per hour.

Multiply yards per hour by 54 grains in one yard of sliver.

$$2339.3 \times 54 = 126322.2.$$

Divide by 7,000 grains.

$126322.2 \div 7000 = 18.046$ pounds per hour.

Multiply pounds per hour by 11.

$18.046 \times 11 = 203$ lbs. per day for one delivery of drawing.

There should be about 20 per cent. deducted from the figured pounds for stoppage. Find draft of the drawing from the following: Back roller gear 60 teeth, crown gear 100, gear on front roller 20, bevel gear on side shaft 18, bevel gear on top coiler upright 16, diameter of coiler 2 inches, draft change gear 45 teeth, gear on end of front roller 24, gear on end side shaft 32, bevel gear on bottom of coiler upright 16, bevel gear on coiler calender 16, diameter of back roller $1\frac{3}{8}$. Change the diameter of the rollers to eighths of an inch which would be, back roller 11-8ths, calender roller 16-8ths. Example:

$$\frac{60 \times 100 \times 20 \times 18 \times 16 \times 16}{45 \times 24 \times 32 \times 16 \times 16 \times 11} = 5.68 \text{ draft.}$$

To get the draft constant we will use the same example as the above with the draft gear left out. Example:

$$\frac{60 \times 100 \times 20 \times 18 \times 16 \times 16}{24 \times 32 \times 16 \times 16 \times 11} = 255.68 \text{ draft constant.}$$

Divide the constant by the draft and the quotient will be the number of teeth in draft gear required; or divide by he teeth in the gear and the result will be the draft of the drawing. If the drawing sliver weighs 60 grains per yard with a 48 draft gear and we wish the sliver to weigh 54 grains, what draft gear will be required?

$$\frac{54 \times 48}{60} = 43.2.$$

If 45 draft gear makes sliver that weighs 50 grains per yard, what will 48-tooth draft gear make it weigh?

$$\frac{50 \times 48}{45} = 53.33.$$

If there are six slivers up on the back of drawing with a 44 draft gear on and we wish to take out one and have but five, and want the front sliver to weigh the same, what draft gear will be required?

$$\frac{44 \times 6}{5} = 52.8 \text{ draft gear.}$$

If the sliver from the coiler weighs 54 grains and the draft 5.5, what weight will be required per yard of each of the six slivers on the back?

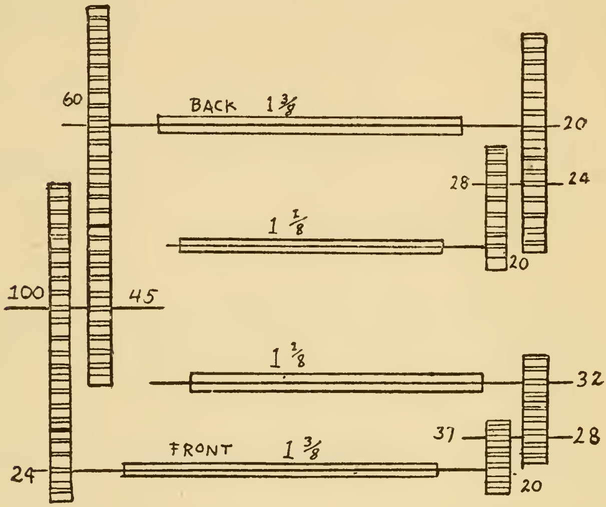
$$\frac{54 \times 5.5}{6} = 49.5 \text{ wt. of sliver on back.}$$

If one yard of sliver on the back weighs 60 grains with six double and the drawing has a draft of 6.5, what will the sliver weigh per yard at the coiler?

$$\frac{60 \times 6}{6.5} = 55.38.$$

CHAPTER IX.

Drafts between all of the bottom rollers on the drawing frame.



The above cut represents the four bottom rollers of the drawing frame with the diameter of the rollers and the number of teeth in each gear marked on them. They are taken from the catalogue and the diagram is given in order to figure the draft between each set of rollers. First get draft of the front and second roller. Example:

$$\frac{32 \times 37 \times 11}{20 \times 28 \times 9} = 2.584.$$

Next get the draft between second and third. This is quite a long example as we figure from the third roller around through the draft gear to the second, and as each roller has the same diameter, leave them out of the example.

$$\frac{20 \times 24 \times 60 \times 100 \times 20 \times 28}{28 \times 26 \times 45 \times 24 \times 37 \times 32} = 1.732 \text{ draft.}$$

Get the draft between third and back roller.

$$\frac{26 \times 28 \times 9}{20 \times 24 \times 11} = 1.240.$$

These three different drafts if run far enough into fractions should get the draft of the drawing when multiplied together.

$$2.584 \times 1.732 \times 1.240 = 5.5496 \text{ draft.}$$

Will figure the draft from the front to the back roller. These rollers have the same diameter, so leave them out of the example and figure the gears only. Example:

$$\frac{100 \times 60}{24 \times 45} = 5.555.$$

If we were to run the fractions till there would be no remainder the draft in the two examples would be the same. Figure the draft between the front roller and the coiler calender from the following gears and diameters: Front roller $1\frac{3}{8}$ inches, diameter front roller gear 17 teeth, coiler shaft driver 31, gear on coiler shaft 18, gear on bottom of upright shaft 16, gear on top upright and calender have the same number of teeth, diameter of coiler calender 2 inches.

$$\frac{17 \times 18 \times 16}{31 \times 14 \times 11} = 1.025 \text{ draft.}$$

If a 30-tooth gear is put on side coiler shaft instead of the 31, what draft will this give between the front and coiler calender rollers?

$$\frac{17 \times 18 \times 16}{30 \times 14 \times 11} = 1.059.$$

If the card sliver weighs 60 grains per yard and the first drawing doubled 6 times and the second 5 times, and we wish the finish drawing sliver to weigh 54 grains and wish each process to have the same draft, what will be the draft? Multiply the doublings at each back together,

$$6 \times 5 = 30.$$

Multiply this product by 60 grains,

$$30 \times 60 = 1800.$$

Divide last result by 54 grains,

$$1800 \div 54 = 33.33.$$

Extract the square root of the last result:

The square root of 33.33=5.773,

draft of each drawing frame. Will see how this example

proves out. If the card sliver weights 60 grains, double 6 into 1, draft 5.773, multiply sliver by doublings,

$$60 \times 6 = 360.$$

Divide by draft,

$$360 \div 5.773 = 62.359$$

grains per yard from first drawing. Multiply this by doubling at back of second drawing,

$$62.359 \times 5 = 311.795$$

Divide by draft,

$$311.795 \div 5.773 = 54$$

weight of sliver from second drawing.

As the next calculations will be on roving frames, the next lesson will be on hank roving.

CHAPTER X.

Hank roving; how it is figured by the card and drawing sliver, also roving.

In cotton mill parlance, eight hundred and forty yards is denominated one hank, whether it be lap, card or drawing sliver, slubber or fine frame roving, or yarns, and the number is fixed by the weight of one hank. If one hank weighs two pounds, it is one-half hank; if one pound, one hank, and if one-half pound, it is two hank. If twenty hanks of yarn weigh one pound, it is No. 20 yarn. Seven thousand grains make one pound avoirdupois weight, or is called one cotton pound. Divide 7,000 grains by 840 yards and it will give 8 1-3 grains per yard for one-hank roving or yarn, and the weight in grains of one yard of one-hank roving or yarn form the basis for calculating all hank sliver, roving or yarn.

It is not practical to reel off one hank of sliver or roving, but more convenient to take so many yards, twelve yards from each (this is the standard given by most books and catalogues in the tables for numbering roving), from four to eight bobbins and reel twelve yards from each and weigh each separately and add the weights together and the yards of each together. The rule to find the hank is to multiply the number of yards of the several weighings by 8 1-3 for

a dividend, and take the grains of the several weighings added together for a divisor and the quotient will be the hank. Take four slubber bobbins and reel 12 yards from each. The first 12 yards weigh 202, the second 198, third 199, fourth 201, what will be the hank roving? Example:

$$12 \times 4 = 48 \text{ yards}$$

Multiply the yards by grains per yard.

$$8\tfrac{1}{3} \times 48 = 400, \text{ dividend}$$

Add the grains of each weighing. Example:

$$202 + 198 + 199 + 201 = 800, \text{ divisor}$$

Example: $400 \div 800 = .50$

hank roving which is one-half hank. Take 12 yards of slubber roving which weigh 180 grains, what hank is it? Example:

$$12 \times 8\tfrac{1}{3} = 100 \div 180 = .555 \text{ hank}$$

Take four bobbins of intermediate roving and reel 12 yards which weigh as follows in grains:

$$85 + 88 + 84 + 86 = 343 \text{ grains.}$$

Yards, $12 \times 4 = 48 \times 8\tfrac{1}{3} = 400 \div 343 = 1.166$ hank.

For 12 yards 100 is the constant dividend and for every 12 yards added add one hundred to the dividend. If 48 yards of roving weigh 130 grains, what will it hank? Example:

$$48 \times 8\tfrac{1}{3} = 400 \div 130 = 3.07.$$

Where four bobbins are used to weigh from and 12 yards are taken from each the multiplication by 8 1-3 can be dispensed with by using 400 for the dividend; or if eight bobbins are used 800 will be the dividend. If 12 yards from each of eight bobbins weigh 560 grains, what will it hank?

$$800 \div 560 = 1.42 \text{ hank.}$$

If one yard of drawing sliver weighs 60 grains, what hank is it? Example:

$$8\tfrac{1}{3} \div 60 = .138 \text{ hank}$$

If one yard of card sliver weighs 52 grains, what will be the hank? Example:

$$8\tfrac{1}{3} \div 52 = .160.$$

If four yards of card sliver weigh 220 grains, what will it hank? Example:

$$4 \times 8\tfrac{1}{3} = 33\tfrac{1}{3} \div 220 = .151 \text{ hank.}$$

If three-hank is wanted from fine frame, what hank will be required of two into one at the back with a draft of six? Example:

$$3 \div 6 = .50 \times 2 = 1.00 \text{ one hank.}$$

Divide the draft by the hank and multiply the quotient by the doublings at the back. Take one-hank roving in the back with two into one and a draft of five, what will be the hank from fine frame? Example:

$$1.00 \div 2 = 50 \times 5.5 = 2.75 \text{ hank.}$$

In this case divide by the doublings at the back and multiply by the draft and the quotient will be the hank roving produced. If we have .60-hank at the back of the intermediate and two into one, what draft will it take to produce 1.20 hank? Example:

$$.60 \div 2 = .30 \quad \frac{1.20}{.30} = 4 \text{ draft.}$$

If we have on the backs of the intermediate 48-hank and two into one and a draft of five, what hank will be produced? Example:

$$.48 \div 2 = .24 \times 5 = 1.20 \text{ hank.}$$

If one yard of drawing sliver weighs 60 gains, what hank is it? Example:

$$8\tfrac{1}{3} \div 60 = .138 \text{ hank.}$$

If at the back of the slubber we have .138-hank sliver, single, what hank roving will be produced with a draft of four? Example:

$$.138 \times 4 - .552 \text{ hank roving.}$$

The expression should be

$$\frac{552}{1000} \text{ hank}$$

CHAPTER XI.

Speed of slubber shaft, spindle, and draft. Twist constant, also other calculations on the slubber

The main line of shafting makes 290 revolutions per minute with a pulley 15 inches in diamter, which drives the main shaft of a slubber having a pulley 16 inches in

diameter; how many revolutions will slubber shaft make per minute? Example:

$$\frac{290 \times 15}{16} = 271.8 \text{ revolutions slubber shaft.}$$

If the main line makes 290 revolutions per minute, what will the spindle make with the following pulleys and gears: Main shaft pulley 15 in., pulley on slubber shaft 16 in., gear on main slubber shaft 50 teeth, gear on end of spindle shaft 46 teeth, gear on spindle shaft 55 teeth, gear on spindle 27 teeth? Example:

$$\frac{290 \times 15 \times 50 \times 55}{16 \times 46 \times 27} = 601.77 \text{ revs. of spindle.}$$

If the slubber is on one-half hank roving, requiring a 59 twist gear and the spindle making 602 revolutions per minute, what will the front roller run from the following gears: Spindle gear 27 teeth, spindle shaft gear 55 teeth, gear on end of spindle shaft 46 teeth, gear on main shaft 50 teeth, twist gear 59 teeth, gear on top cone shaft 46 teeth, gear on cone shaft inside of head 71 teeth, front roller gear 130 teeth? Example:

$$\frac{602 \times 27 \times 46 \times 59 \times 71}{55 \times 50 \times 46 \times 130} = 190.45$$

With the front roller making 190 revolutions per minute, what will the back roller make in the same time with the following gears: Front roller gear 33 teeth, gear on stud 100 teeth, draft gear 50 teeth, back roller gear 56 teeth? Example:

$$\frac{190 \times 33 \times 50}{100 \times 56} = 55.96 \text{ revolutions of back roller.}$$

The front roller is 19-16 inches in diameter and makes 190 revolutions, and the back roller is 1 inch in diameter and makes 55.96 revolutions, what draft will this give? Example:

$$\frac{190 \times 19}{55.96 \times 16} = 4.030 \text{ draft.}$$

We will see how this will figure out by the rule to get the draft. Example:

$$\frac{100\times56\times19}{33\times50\times16}=4.030 \text{ draft.}$$

Rule: Multiply all of the drivens together with the diameter of front roller for a dividend, and all of the drivers with diameter of back roller for a divisor. The draft constant is figured by the same example with the draft gear left out. Example:

$$\frac{100\times56\times19}{33\times0\times16}=201.515 \text{ constant.}$$

Divide the constant by the draft desired and the quotient will be the number of teeth in draft gear, or divide by number of teeth in gear and the quotient will be the draft.

How many turns will the spindle make to one of the front roller with the following gears: Front roller gear 130 teeth, cone shaft 71 teeth, center cone shaft 46 teeth, twist gear 59 teeth, gear on main shaft 50 teeth, gear on end spindle shaft 46 teeth, gear on spindle shaft 55 teeth, gear on spindle 27 teeth? Example:

$$\frac{130\times46\times50\times55}{71\times59\times46\times27}=3.1638 \text{ turns of spindle to one of roller.}$$

To get the turns of twist per inch divide the turns of the spindle to one turn of the front roller by the circumference of the front roller, which is 3.731 inches. Example:

$$3.1638\div3.731=.847 \text{ turns per inch.}$$

To get the twist constant will use the above example with the twist gear left out and the circumference of the front roller put in its place. Example:

$$\frac{130\times46\times50\times55}{71\times3.731\times46\times27}=49.9837, \text{ constant.}$$

Divide constant by number of teeth in twist gear and the quotient will be turns per inch of twist in the roving, or divide by the number of turns of twist desired per inch and the quotient will give number of teeth in the twist gear. In figuring the draft gear to change from one hank to another. Rule: Multiply the number of teeth in draft gear on by the hank roving being made and divide by hank desired and the quotient will be the answer.

If a draft gear with 50 teeth gives one-half hank roving,

what number of teeth will it take to make .60 hank? Example:

$$\frac{50 \times 50}{.60} = 41.6 \text{ draft gear}$$

Or if a .70 hank requires a 45 draft gear, what will .60 hank require? Example:

$$\frac{.70 \times 45}{.60} = 52.5.$$

To find the twist gear when changing from one hank to another. Rule: Square the twist gear on and multiply this product by the hank being made and divide by the hank to be made. Extract the square root of the last product and the quotient will be the number of teeth in twist gear desired.

One-half hank has a twist gear with 59 teeth, what number of teeth will it take for .60 hank? Example:

$$59 \times 59 \times .50 \div .60 = \sqrt[2]{2900} = 53.5.$$

Another rule is to multiply the gear in use by the square root of the roving being made and divide by the square root of the roving to be made.

CHAPTER XII.

Intermediate twist constant, production of one spindle, also production of a number of frames. The tension gear and the rule to get the number of coils per inch for hank roving.

The intermediate roving frames have the same size diameter of front and back rollers and the same draft gears, and the draft and draft constants are the same as the slubber. But there is some difference in the number of teeth in the gears from the top cone to the spindle, that makes a different twist constant, which is figured by the following gears: Front roller gear 130 teeth, on end of cone shaft gear 71 teeth, gear in center of cone shaft 39 teeth, gear on main shaft 42 teeth, gear on end spindle shaft 35 teeth, gear on spindle shaft 44 teeth, spindle gear 23 teeth, circumference of front roller 3.731 inches. Example:

$$\frac{130\times39\times42\times44}{71\times5.731\times35\times23}=43.937\text{, twist const.}$$

If the spindle makes 746 revolutions per minute, what will the front roller make with a 37 twist gear on, the other gears being as follows: Front roller 130 teeth, gear on end of cone shaft 71 teeth, gear at center of cone shaft 39 teeth, twist gear 37 teeth, gear on main shaft 42 teeth, gear on end of spindle shaft 35 teeth, gear on spindle shaft 44 teeth, spindle gear 23 teeth? Example:

$$\frac{746\times23\times35\times37\times71}{44\times42\times39\times130}=168.37\text{ rev. of front roller.}$$

If the front roller makes 168 revolutions per minute and the roving one hank, how many pounds will one spindle take off in ten hours if it is run without stopping, diameter of roller 1 3-16? Multiply the revolutions of the roller per minute by 60 minutes and by 10 hours and by the circumference of the roller. Example:

$$168\times60\times10\times3.731=376084.8.$$

This product is inches which have been delivered in the ten hours, and we divide by 36 inches, which makes yards, and by 840, which makes hanks. Example:

$$840\times36\times30240.$$

Then divide. Example:

$$376084.8\div30240=12.43.$$

Divide this product by the hank roving and the quotient will be pounds. The roving is one hank, which will make 12.43 pounds in ten hours. To get the pounds per day taken off one frame, multiply the number of hanks registered by the indicator by the number of spindles on the frame and divide by the hank roving being made. Take a frame with 68 spindles on 1.25 hank and run 12 hanks per day, what number of pounds will be produced? Example:

$$\frac{68\times12}{1.25}=652.8\text{ pounds.}$$

Where there are several frames with the same number of spindles and on the same hank roving, take the number of hank run on all the frames and multiply by the number of spindles on one frame and divide by the hank roving made. Take 12 intermediate frames with 92 spindles on each making 1.40 hank, and all of the hanks from each added together amounts to 132 hanks in one day, what is the production in pounds? Example:

$$\frac{132\times92}{1.40}=8674.28\text{ pounds.}$$

We get the lay gear constant as follows: Multiply the square root of the hank roving being made by the number of teeth in the lay gear in use. What is the lay constant with a 28 lay gear making 1.10 hank roving, the square root of 1.10 hank being 1.049? Example:

$$28 \times 1.049 = 29.372, \text{ lay constant.}$$

If we change this frame onto 80 hank what lay gear will be required? Divide the lay constant by the square root of the hank to be made. The square root of .80 hank is .894. Example:

$$\frac{29.372}{.894} = 32.85 \text{ lay gear.}$$

The tension gear is figured for the constant the same as the lay. To get the coils per inch to be laid on the bobbin for different hank roving, get the number of coils per inch on one hank that will make the best bobbin of roving, usually 11 or 12. This number of layers per inch on one hank roving forms the basis for figuring the coils per inch for all numbers or hank roving, and from the fact that the coarser the roving the smaller number of layers to the inch. Unlike the twist and lay gear, in which the coarser the roving the larger the gears, we reverse the terms in multiplying and dividing. Rule: Multiply the coils per inch of the roving being made by the square root of the hank roving to be made and divide by the square root of the hank roving being made. If one hank roving has 11 coils per inch, what will be required for two hank? Example:

$$\frac{11 \times 1.4142}{1.000} = 15.5562 \text{ coils per inch.}$$

If one hank has 10 coils per inch, what will ½ hank require? Example:

$$\frac{10 \times .7071}{1.000} = 7.07 \text{ coils for } \tfrac{1}{2} \text{ hank.}$$

If three hank has 17 coils per inch, what should six hank have? Example:

$$\frac{17 \times 2.4494}{1.7320} = 24.0414 \text{ coils per inch.}$$

CHAPTER XIII.

Calculations on the Fine Roving Frame, Which is the Biddeford, 3 1-2 inch Flyer by 8 inch Traverse.

The draft gears are the same as the slubber and intermediate, but the front roller being smaller in diameter, the draft constant is different, and is figured as follows: Gear on front roller 33 teeth, gear on stud 100 teeth, draft leave out, back roller gear 56 teeth. Diameter of front roller $1\frac{1}{8}$ or 18-16, back roller 1 inch or 16-16. Example:

$$\frac{18\times100\times56}{16\times56}=190.909 \text{ draft constant.}$$

The gears and diameter of front roller being different, the twist constant will be different from the coarser frames, and is figured from the following: Gear on front roller 130 teeth, gear on end of top cone shaft 71 teeth, gear on center of cone shaft 39 teeth, twist gear leave out, gear on main shaft 53 teeth, gear on end of spindle shaft 33 teeth, gear on spindle shaft 44 teeth, gear on spindle 23 teeth, circumference of front roller 3.534. Example:

$$\frac{130\times39\times53\times44}{71\times3.534\times33\times23}=62.0826 \text{ twist constant.}$$

Circumference of the front roller is put in the place of twist gear in the above example. If the frame is on two hank roving, what number of coils should be laid to the inch on the bobbin? (See rule given for intermediate frame.) One hank has 11 coils per inch and the square root is 1.000; the square root of two hank is 1.414. Multiply the 11 layers on one hank by the square root of two hank and divide by the square root of the one hank. Example:

$$\frac{11\times1.414}{1.000}=15.554 \text{ layers.}$$

How many turns of twist per inch should two hank roving have by the standard? Multiply the square root of the hank roving by 1.20; the square root of two hank is 1.414. Example:

$$1.414\times1.20—1.6968 \text{ twists per inch.}$$

What number of teeth will it take in the twist gear for two hank? Divide twist constant by the number of turns per inch required. Example:

$$62.0826\div1.6968=36.58 \text{ twist gear.}$$

If the frame is running on two hank roving with 15.5

layers per inch on the bobbin, 1.69 turns of twist per inch with 37 teeth twist gear, 55 teeth tension gear and a 40 teeth lay gear, what number of layers and twist per inch and number of teeth in each gear will be required for three hank roving? First get the layers, multiply the square root of three hank by the two hank layers, divide by the square root of two hank. Example:

$$\frac{1.732 \times 15.5}{1.414} = 18.98 \text{ layers per in. for 3 hank.}$$

Second, twist per inch. Multiply square root of three hank by 1.20. Example:

$$1.732 \times 1.20 = 2.088 \text{ twists per inch.}$$

Third, divide twist constant by twist per inch in the three hank for the twist gear. Example:

$$62.0826 \div 2.088 = 29.73 \text{ twist gear.}$$

Fourth, multiply lay gear by the square root of the roving being made and divide by the square root of the roving to be made, for the lay gear. Example:

$$\frac{40 \times 1.414}{1.732} = 32 \text{ lay gear.}$$

Fifth, the tension gear is figured like the lay gear. Example:

$$\frac{55 \times 1.414}{1.732} = 44.9 \text{ tension gear.}$$

In changing from one number of roving to any other number the layers, twist per inch and number of teeth in the gears are figured as above and will apply to any of the roving frames. On three hank roving, with the front roller 1⅛ inches in diameter and making 145 revolutions per minute, how many hanks will one spindle produce in 10 hours, if the frame runs without stopping? Multiply the revolutions per minute of front roller by 60 minutes, by 10 hours, and by the circumference of front roller, and divide this product by 36 inches and 840 yards and the quotient will be hanks. Example:

$$\frac{145 \times 60 \times 10 \times 3.534}{36 \times 840} = 10.16 \text{ hanks per day.}$$

If the frame has 160 spindles and runs ten hanks of three

hank roving, what will be the production in pounds? Example:

$$\frac{10\times160}{3}=533 \text{ pounds.}$$

Rule: Multiply the number of hanks by the number of spindles on one frame and divide by the hank roving.

There are twenty frames of 160 spindles to each frame, all running on 2.75 hank roving, and the hanks from all of the frames added together amount to 210. What is the production per day in pounds? Example:

$$\frac{210\times160}{2.75}=12218 \text{ pounds per day.}$$

Ten per cent. should be deducted from the above products for stoppage.

CHAPTER XIV.

What one tooth change at any preceeding process will effect the hank roving on the fine frame.

In this case we leave off the weight in grains and hank roving, and figure from the gears, except at the fine frame, we use only the hank roving. For an example, take the fine frame which has a 34 tooth draft gear and making 3 hank roving; the intermediate has 45 teeth draft gear and slubber 60 teeth. Suppose we build up one tooth on the slubber and one tooth on the intermediate. First find what the one tooth on the slubber will change the three hank. Example:

$$\frac{60\times3.00}{61}=2.95 \text{ hank.}$$

Second, find what the one tooth change on the intermediate will change the 2.95 hank on the fine frame. Example:

$$\frac{45\times2.95}{46}=2.88 \text{ hank,}$$

which the two changes will make in the three hank on the fine frame. But after making these two changes we wish to change the draft gear on the fine frame so the roving will remain three hank, which calls for the draft gear on the

fine frame in the example, as follows:

$$\frac{34 \times 2.88}{3.00} = 32.64 \text{ draft gear.}$$

Suppose we heavy up two teeth on the draft gear on coarse drawing and change one tooth lighter on the fine drawing, how will these two changes affect the three hank roving on the fine frame? The coarse drawing has on 47 draft gear; put on a 49 gear and find what this will make the three hank. Example:

$$\frac{47 \times 3.00}{49} = 2.87 \text{ hank.}$$

The fine drawing has on 47 draft gear; put on a 46 gear and find what this will change the 2.87 hank on the fine frame. Example:

$$\frac{47 \times 2.87}{46} = 2.93 \text{ hank.}$$

What draft gear will be required on the fine frame to bring the roving back to three hank with a 34 tooth gear on the fine frame. Example:

$$\frac{34 \times 2.93}{3.00} = 33.20 \text{ draft gear.}$$

The rule for figuring a change like the above example is simple and the same as the rule used to figure the same changes on the fine frame, which is, multiply the draft gear on by the hank roving being made and divide by the gear put on whether the change is made on the intermediate, slubber, drawing or card. Where a change is to be made from a certain hank to another hank roving, multiply the hank being made by the draft gear on and divide by the hank to be made. Take the fine frame on three hank and change to four hank by changing the draft gear on the card which has a 20 tooth draft gear on. Example:

$$\frac{3.00 \times 20}{4.00} = 15 \text{ draft gear.}$$

Or say 60 grains card sliver makes three hank roving, how many grains must sliver weigh for four hank? Example:

$$\frac{60 \times 3.00}{4.00} = 45 \text{ grains.}$$

If we are making two hank roving with a 14 ounce lap and change to 2.50 hank by making the lap lighter, what ounce lap will be required? Example:

$$\frac{2.00 \times 14}{2.50} = 11.2 \text{ oz. per yd. of lap.}$$

If the intermediate has a 45 tooth draft gear on, the slubber 60, the fine drawing 46, coarse drawing 47 and card draft gear 16 teeth, and we change one tooth heavy at each process, how will these changes affect three hank roving on the fine roving frame? First, the intermediate has 45 and we put on 46 tooth draft gear. Example:

$$\frac{45 \times 3.00}{46} = 2.93 \text{ hank.}$$

The slubber has 60; put on 61 draft gear and find how much this will change the 2.93 hank. Example:

$$\frac{60 \times 2.93}{61} = 2.88 \text{ hank.}$$

The drawing has 46 teeth; put on a 47 tooth draft gear. Find what this will change the 2.88 hank. Example:

$$\frac{46 \times 2.88}{47} = 2.818.$$

The coarse drawing has 47; put on a 48 draft gear and see what this will change the 2.818 hank. Example:

$$\frac{47 \times 2.818}{48} = 2.755 \text{ hank.}$$

The card draft gear has 16 teeth; put on a 17 tooth gear and find what it will change the 2.755 hank on the fine frame. Example:

$$\frac{16 \times 2.755}{17} = 2.59 \text{ hank roving on the fine frame.}$$

The one tooth change at the five different processes makes a change on the fine frame three hank roving from three hank to 2.59 hank.

The above example demonstrates the fact that the smaller number of teeth the draft gears have, the greater change one

tooth will make in the weight or number of the roving, and the more teeth the less one tooth will change the number. This is why I make my changes in keeping numbers on the large gear on the draft gear stud, in place of changing the draft pinion. This gear on the Biddeford frame has 100 teeth, and one tooth change on this gear makes one pound in the hundred pounds in the cloth room, while the change pinion has about 33 teeth, and one tooth change will make three pounds in the hundred.

CHAPTER XV.

How to figure the weight of lap to produce a certain hank roving at the fine frame, also the weight per yard at any process to produce any hank roving.

The two most important questions to decide before we can solve this problem are the drafts and doublings on each process; and to make the solution as simple and plain as possible, I will take the schedule of drafts and doublings as are used in the new Dallas Mills, which are as follows: Card draft 95, drawing draft coarse head 6 and double 6, fine drawing draft 6 and double 6, slubber draft 3.50, intermediate draft 4.50 and double 2, fine frame draft 5.50 double 2. By this schedule we will find the requisite weight per yard of lap to produce three hank roving on the fine roving frame.

In figuring from the roving frame back to the card, multiply the weight in grains of one or more yards by the draft and divide by the doublings. First, 12 yards of three hank weigh s 33 1-3 grains with two doublings and 5.50 draft; what will 12 yards of intermediate roving weigh in grains? Example:

$$\frac{33\frac{1}{3}\times 5.50}{2} = 91.66 \text{ grains weight of 12 yards.}$$

Secondly, 12 yards of intermediate roving weighs 91.66 grains and with two doublings and a draft of 4.50, what will 12 yards of slubber roving weigh in grains? Example:

$$\frac{91.66 \times 4.50}{2} = 206.23 \text{ grains.}$$

The slubber has a draft of 3.50 and no doublings. We multiply the 206.23 grains by the draft and divide by 12 yards; this will give what one yard of drawing sliver will weigh in grains. Example:

$$\frac{206.23 \times 3.50}{12} = 61.41 \text{ grs. per yard of fine drawing sliver.}$$

As the two processes of drawing draw six times and double six times, this will make the card sliver the same weight per yard as the fine drawing sliver, which is 61.41 grains. Thereis no doubling on the card. Multiply the weight of sliver by the draft of the card; this will give the grains in one yard of lap; divide this product by 437.5, which are the grains in one ounce, and the quotient will be ounces per yard of lap. Example:

$$61.41 \times 95 = 5833.95 \div 437.5 = 13.33 \text{ ounces in one yard of lap.}$$

There is no deduction made in the above for waste nor any allowance for contraction. By the above schedule of drafts and doublings will be found the required weight per yard of the fine drawing sliver to produce four hank roving on the fine roving frame. Twelve yards of four hank roving weighs 25 grains, draft of fine roving frame 5.50 double two times, draft of intermediate 4.50, double two times, draft of slubber 3.50 and no doubling. Example:

$$\frac{25 \times 5.50 \times 4.50 \times 3.50}{2 \times 2} = 541.40 \text{ grains in 12 yards drawing sliver.}$$

Divide by 12 yards and the quotient gives grains in one yard of sliver.

$$541.40 \div 12 = 45.11 \text{ grains in one yard.}$$

Rule: Multiply the weight in grains of 12 yards of fine roving and the draft of each process together for a dividend and the doublings of each process together for a divisor, and the quotient will give the weight in grains of 12 yards, which divided by 12 will give the weight of one yard.

I will change the schedule of the drafts on each process and use whole numbers, to eliminate fractions, which will simplify the operation. Card draft 90, coarse drawing draft 5, fine drawing draft 5, slubber draft 4, intermediate draft 5,

fine frame draft 6, the doublings the same as in the first schedule. What weight per yard of lap will be required to produce two hank roving on the fine roving frame by the last schedule? Multiply the 12 yards by the doublings to give one yard of lap in grains. Twelve yards of two hank roving weighs 40 grains. Example:

$$\frac{40 \times 6 \times 5 \times 4 \times 5 \times 5 \times 90}{12 \times 2 \times 2 \times 0 \times 6 \times 6} = 6250 \text{ grains in 1 yard of lap.}$$

Divide by grains in one ounce, which is 437.5. Example:

$$6250.0 \div 437.5 = 14.28 \text{ oz. per yard of lap.}$$

When figuring from the card to the roving frame multiply the weight in grains of one yard of lap and all of the doublings and 12 yards together for a dividend and all of the drafts together for a divisor, the quotient will give the weight in grains of 12 yards of fine roving from the last schedule of drafts and doublings. Will find what a 12 ounce per yard of lap will give in hank roving on the fine roving frame. Twelve ounces of lap contains 5250 grains. Example:

$$\frac{5250 \times 12 \times 2 \times 2 \times 6 \times 6}{90 \times 5 \times 5 \times 4 \times 5 \times 6} = 33.6 \text{ grains in 12 yards of fine roving.}$$

Divide 100 by the last results and it will give the hank roving. Example:

$$100 \div 33.6 = 2.97 \text{ hank roving.}$$

From the present schedule we will find what the roving and sliver at each process should weigh to produce a given hank roving with a draft of 6 on fine roving frame. What will the intermediate roving have to weigh to produce two hank roving? Twelve yards of two hank weigh 50 grains and double two times. Example:

$$\frac{50 \times 6}{2} = 150 \text{ grains per 12 yards.}$$

With six draft on fine frame and double two times, and 5 draft on the intermediate and double two times, what will 12 yards of slubber roving have to weigh to produce 2.50 hank roving on the fine frame? Twelve yards of 2.50 hank weigh 40 grains. Example:

$$\frac{40 \times 6 \times 5}{2 \times 2} = 300 \text{ grains per 12 yards.}$$

With 6 draft on fine roving frame and double two times, 5 draft on the intermediate and double two times, and a draft of 4 on slubber, what weight of fine drawing sliver per yard will it take to produce three hank on fine roving frame? Twelve yards of three hank weigh 33 1-3 grains. Example:

$$\frac{33\frac{1}{3}\times6\times5\times4}{12\times2\times2}=83.33, \text{ one yard of sliver.}$$

With 6 draft on fine frame, 5 draft on intermediate, 4 draft on slubber and 5 draft on fine drawing, what weight must coarse drawing sliver be to produce two hank roving? Twelve yards of two hank weigh 50 grains. Example:

$$\frac{50\times6\times5\times4\times5}{12\times2\times2\times6}=104.16.$$

With 6 draft on fine roving frame, 5 draft on intermediate, 4 on slubber, 5 on fine drawing, 5 on coarse drawing, what must card sliver weigh per yard to produce four hank on fine roving frame? Twelve yards of four hank weigh 25 grains. Example:

$$\frac{25\times6\times5\times4\times5\times5}{12\times2\times2\times6\times6}=43.40, \text{ 1 yard card sliver.}$$

When starting a new mill it is necessary to have a schedule of drafts and weights for each process, and as the stock is put through each process the sliver or roving should weigh the same as scheduled or be made to do so by changing the drafts.

CHAPTER 17.

Care of the Card Lickerin.

This part of the card is all-important, and is largely responsible for the quality of work turned off, and its capacity for cleaning the stock of dirt, motes, leaf and lump, makes it an armour of protection for the wire on the cylinder and flats, and its duty well perofrmed will cut down cost of grinding and double the life of the clothing. To bring the lickerin up to its highest efficiency will require going into minor details and we shall proceed in this direction by taking off the cap and examining the wire. If it is very dull or forced up from rubbing the mote knives of feed plate, the best thing to do is to take it out and place it in some kind of stand—two horses of the right height will do. If these are not convenient, we can take it to the lathe, run it backward slowly, and with a hand-saw file run in all of the spiral grooves from end to end. It is best not to have the wire to a fine point, for if extremely sharp, it will cut up the stock and make much unnecessary waste.

If the shrouds have the lip that comes over to the end of the lickerin, like the first made by the Pettee shops, they should be taken to the lathe and have the lip turned off, making plain heads of them: this will save much trouble with chokes in the head, which cause fires. After getting the wire in condition, we put the lickerin back into place, and set it to the cylnder with a No. 7 card guage. We set close at this point in order to have the cylinder take all of the stock clean from the lickerin; for if any stock passes this point and goes to the feed plate again, it will cause cloudy carding. Here, we take the lickerin out and examine the screen. To do this properly it is necessary to have a screen gauge, which I will describe here, so one can make it for his own use. Procure a piece of smoothly turned shafting, 1¼ inches in diameter, long enough to reach across the card, taking in the lickerin boxes. Get a wheel sufficiently large, bore the hub to fit the shafting nicely, so it will slide easily on it from end to end, turn the face to the exact diameter of the lickerin over the wire. This wheel need not be over one-fourth of an inch thick on the

face. Put a collar on each end of the shafting, turn them to fit the lickerin boxes with shrouds out: it is now ready for use, and we put it in the place of the lickerin. By moving the guage from one side to the other we can see how the screen is set to the lickerin, also detect any high or low places, bumps or dents, or any defect in the shape of the screen, which should conform to the guage or be made to do so, throughout its length and breadth.

On cards that have not been terated with something like this guage, I invariably find on putting in the guage, a pocket or large open space at the bottom part of the piece that is made to the cylinder screen and forms part of the licker-in screen. This open space must be gotten out, and the only way to do so is to raise this end of the cylinder screen straight up with the set screws on the side of the card. Bring it up until the screen will be the same distance from the guage at bottom as at the top. This open space will allow the fibres to collect in flakes when the lickerin will take them into the cylinder and cause cloudy carding. It will also let the fibres blow to the end of the lickerin and collect in bunches, which when large enough, will be caught by the wire and taken through, and cause the sliver to break down in front of the doffer, or at the coiler head. This part of the screen should be set as close to the guage as we can get it without touching, for this reason: the cylinder when at full speed will create a strong draft of air which will pass out under the lickerin through any open space, taking good stock with it into the waste, and by setting this part close, will cut off this draft. Having this point right, we put on the lickerin screen proper, and the best form of which are those that are made in two pieces, and we put on the first piece; this should be set as close or the same as the one already set. The last or ribbed part is put on with the nose or part next to the mote knives tipped off one-fourth of an inch from the guage. This is done to stop good stock from falling out into the waste.

The mote knives demand our attention next. These were a great invention, and add largely to the capacity of the lickerin for cleaning the stock, and there is a secret in setting these knives, only possessed by the intelligent, who has given them unreserved serious thought and study. These

can be set to take out a large quantity of short fibre with the motes, dirt and leaf, or set to take out nothing but motes, dirt and leaf. They are made so they can be set at any angle to the lickerin. The further off from the lickerin we set the bottom of the knives the more short fibre will be thrown out and the nearer we set them to a perpendicular the less fibre will be thrown out. Some mills want as much as possible of the short fibre taken out, while others want as little as is consistent with the motes, dirt and leaf taken out. The secret lies in finding the angle to set the knives to suit the stock and quality of goods to be made. These knives should be as stiff as possible, and fit tightly in the brackets at the end. If they are not it will be impossible to set them as close as they should be on account of coming in contact with the lickerin. When in motion they should be set at the top as close as we can get them without touching. When the angle is right, they should be raised straight up if necessary, to kep the wire on the lickerin from striking on top of the edge of the knife, should they come in contact with each other. The wire should strike just below the top edge, this prevents the knife from being turned out should they come together. The knives and feed plate should never be allowed to rub the lickerin wire. This will force it up and put it in bad condition for carding. We have the screen and knives set, we put the lickerin into place, we have the lickerin set to the cylinder, we only have to set the feed plate, and this is done with two leaves of the gauge together, which is a ten and a seven, which makes seventeen card gauge; closer than this has a tendency to weaken the yarn. When the feed plate is further off than it should be, the stock will be taken in by flakes and make cloudy work. Or, if the wire is very dull it will have the same effect on the sliver. Take a dull lickerin or one that is off too far from feed plate and gets down under card while running, and if we watch it we see pieces of stock as large as our thumb come below the feed plate before it is taken into the cylinder. The fact that this will make cloudy carding does not require a hydraulic press to get it into the major ity of carders' heads. The lickerin plays a very important part in the quality of the work turned off and it exerts quite a large influence on the running of the card, good or

bad. All of the pockets or open spaces around the lickerin must be gotten rid of so that every fibre which is fed in at the feed plate will go through; it must not stop and collect in bunches; if it does, there will be trouble somewhere. We see a card that seems to run well and to do good work, but frequently it will break down in front of the doffer, or at the coiler head. I have no doubt that there are many rooms that worry along in this condition and the carder thinks it is the nature of the thing and cannot be helped. The lickerin can cause all of this trouble as well as other parts of the card.

If the directions given above are strictly followed in the settings, we will have a card, so far as the lickerin is concerned, that will run day in and day out without the sliver breaking down in front of the doffer or at the coiler head, unless caused by piecing in lap. This part of the card is neglected more than any other piece of machinery in the mill, presumably on account of the dirt and dust, as it is somewhat unpleasant to crawl about under the card, especially when running. But it pays to bring the lickerin up to its highest efficiency. Get one right and then set all the rest like it. To do this properly we should have a gauge made with the angle just right. Place it on the card frame and have the blade to rest against the bracket that holds the knives. In this way we can get them all set alike. The settings given are for stock one inch long and under. The lickerin needs more attention, care, serious thought and study than some men give their room in a lifetime.

A few years ago it was impossible to take a line of ten or twelve cards and make them all do the same quality of work. Some would be cloudy with all we could do, or some would do better than others along the line. Every card seemed to be a machine peculiar to itself. But of late years the pieces are duplicates, every piece the same and fit on any card that is made by the same pattern, and it is but little trouble in a room of eighty or a hundred cards to have the sliver from every card to look the same. There is but one excuse and that is incompetency of the carder, and I will add laziness to his sin of omission.

Though it would not be expected for a carder to take a room that has been butchered up like some rooms are and make all of the cards do the same quality of carding.

CHAPTER 17.

Care of the Card Lickerin.

This part of the card is all-important, and is largely responsible for the quality of work turned off, and its capacity for cleaning the stock of dirt, motes, leaf and lump, makes it an armour of protection for the wire on the cylinder and flats, and its duty well perofrmed will cut down cost of grinding and double the life of the clothing. To bring the lickerin up to its highest efficiency will require going into minor details and we shall proceed in this direction by taking off the cap and examining the wire. If it is very dull or forced up from rubbing the mote knives of feed plate, the best thing to do is to take it out and place it in some kind of stand—two horses of the right height will do. If these are not convenient, we can take it to the lathe, run it backward slowly, and with a hand-saw file run in all of the spiral grooves from end to end. It is best not to have the wire to a fine point, for if extremely sharp, it will cut up the stock and make much unnecessary waste.

If the shrouds have the lip that comes over to the end of the lickerin, like the first made by the Pettee shops, they should be taken to the lathe and have the lip turned off, making plain heads of them: this will save much trouble with chokes in the head, which cause fires. After getting the wire in condition, we put the lickerin back into place, and set it to the cylnder with a No. 7 card guage. We set close at this point in order to have the cylinder take all of the stock clean from the lickerin; for if any stock passes this point and goes to the feed plate again, it will cause cloudy carding. Here, we take the lickerin out and examine the screen. To do this properly it is necessary to have a screen gauge, which I will describe here, so one can make it for his own use. Procure a piece of smoothly turned shafting, 1¼ inches in diameter, long enough to reach across the card, taking in the lickerin boxes. Get a wheel sufficiently large, bore the hub to fit the shafting nicely, so it will slide easily on it from end to end, turn the face to the exact diameter of the lickerin over the wire. This wheel need not be over one-fourth of an inch thick on the

face. Put a collar on each end of the shafting, turn them to fit the lickerin boxes with shrouds out: it is now ready for use, and we put it in the place of the lickerin. By moving the guage from one side to the other we can see how the screen is set to the lickerin, also detect any high or low places, bumps or dents, or any defect in the shape of the screen, which should conform to the guage or be made to do so, throughout its length and breadth.

On cards that have not been terated with something like this guage, I invariably find on putting in the guage, a pocket or large open space at the bottom part of the piece that is made to the cylinder screen and forms part of the licker-in screen. This open space must be gotten out, and the only way to do so is to raise this end of the cylinder screen straight up with the set screws on the side of the card. Bring it up until the screen will be the same distance from the guage at bottom as at the top. This open space will allow the fibres to collect in flakes when the lickerin will take them into the cylinder and cause cloudy carding. It will also let the fibres blow to the end of the lickerin and collect in bunches, which when large enough, will be caught by the wire and taken through, and cause the sliver to break down in front of the doffer, or at the coiler head. This part of the screen should be set as close to the guage as we can get it without touching, for this reason: the cylinder when at full speed will create a strong draft of air which will pass out under the lickerin through any open space, taking good stock with it into the waste, and by setting this part close, will cut off this draft. Having this point right, we put on the lickerin screen proper, and the best form of which are those that are made in two pieces, and we put on the first piece; this should be set as close or the same as the one already set. The last or ribbed part is put on with the nose or part next to the mote knives tipped off one-fourth of an inch from the guage. This is done to stop good stock from falling out into the waste.

The mote knives demand our attention next. These were a great invention, and add largely to the capacity of the lickerin for cleaning the stock, and there is a secret in setting these knives, only possessed by the intelligent, who has given them unreserved serious thought and study. These

can be set to take out a large quantity of short fibre with the motes, dirt and leaf, or set to take out nothing but motes, dirt and leaf. They are made so they can be set at any angle to the lickerin. The further off from the lickerin we set the bottom of the knives the more short fibre will be thrown out and the nearer we set them to a perpendicular the less fibre will be thrown out. Some mills want as much as possible of the short fibre taken out, while others want as little as is consistent with the motes, dirt and leaf taken out. The secret lies in finding the angle to set the knives to suit the stock and quality of goods to be made. These knives should be as stiff as possible, and fit tightly in the brackets at the end. If they are not it will be impossible to set them as close as they should be on account of coming in contact with the lickerin. When in motion they should be set at the top as close as we can get them without touching. When the angle is right, they should be raised straight up if necessary, to kep the wire on the lickerin from striking on top of the edge of the knife, should they come in contact with each other. The wire should strike just below the top edge, this prevents the knife from being turned out should they come together. The knives and feed plate should never be allowed to rub the lickerin wire. This will force it up and put it in bad condition for carding. We have the screen and knives set, we put the lickerin into place, we have the lickerin set to the cylinder, we only have to set the feed plate, and this is done with two leaves of the gauge together, which is a ten and a seven, which makes seventeen card gauge; closer than this has a tendency to weaken the yarn. When the feed plate is further off than it should be, the stock will be taken in by flakes and make cloudy work. Or, if the wire is very dull it will have the same effect on the sliver. Take a dull lickerin or one that is off too far from feed plate and gets down under card while running, and if we watch it we see pieces of stock as large as our thumb come below the feed plate before it is taken into the cylinder. The fact that this will make cloudy carding does not require a hydraulic press to get it into the major ity of carders' heads. The lickerin plays a very important part in the quality of the work turned off and it exerts quite a large influence on the running of the card, good or

bad. All of the pockets or open spaces around the lickerin must be gotten rid of so that every fibre which is fed in at the feed plate will go through; it must not stop and collect in bunches; if it does, there will be trouble somewhere. We see a card that seems to run well and to do good work, but frequently it will break down in front of the doffer, or at the coiler head. I have no doubt that there are many rooms that worry along in this condition and the carder thinks it is the nature of the thing and cannot be helped. The lickerin can cause all of this trouble as well as other parts of the card.

If the directions given above are strictly followed in the settings, we will have a card, so far as the lickerin is concerned, that will run day in and day out without the sliver breaking down in front of the doffer or at the coiler head, unless caused by piecing in lap. This part of the card is neglected more than any other piece of machinery in the mill, presumably on account of the dirt and dust, as it is somewhat unpleasant to crawl about under the card, especially when running. But it pays to bring the lickerin up to its highest efficiency. Get one right and then set all the rest like it. To do this properly we should have a gauge made with the angle just right. Place it on the card frame and have the blade to rest against the bracket that holds the knives. In this way we can get them all set alike. The settings given are for stock one inch long and under. The lickerin needs more attention, care, serious thought and study than some men give their room in a lifetime.

A few years ago it was impossible to take a line of ten or twelve cards and make them all do the same quality of work. Some would be cloudy with all we could do, or some would do better than others along the line. Every card seemed to be a machine peculiar to itself. But of late years the pieces are duplicates, every piece the same and fit on any card that is made by the same pattern, and it is but little trouble in a room of eighty or a hundred cards to have the sliver from every card to look the same. There is but one excuse and that is incompetency of the carder, and I will add laziness to his sin of omission.

Though it would not be expected for a carder to take a room that has been butchered up like some rooms are and make all of the cards do the same quality of carding.

TWIST OF ROVING

Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.
.10	.316	.38	.57	.755	.91	1.28	1.131	1.36	2.22	1.490	1.79	3.63	1.905	2.29	5.32	2.307	2.77
.11	.332	.40	.58	.762	.91	1.30	1.140	1.37	2.25	1.500	1.80	3.66	1.913	2.30	5.36	2.315	2.78
.12	.346	.41	.59	.768	.92	1.32	1.149	1.38	2.28	1.510	1.81	3.69	1.921	2.31	5.40	2.324	2.79
.13	.361	.43	.60	.775	.93	1.34	1.158	1.39	2.31	1.520	1.82	3.72	1.929	2.31	5 44	2.332	2.80
.14	.374	.45	.61	.781	.94	1.36	1.166	1.40	2.34	1.530	1.84	3.75	1.936	2.32	5.48	2.341	2.81
.15	.387	.46	.62	.787	.94	1.38	1.175	1.41	2.37	1.539	1.85	3.78	1.944	2.33	5.52	2.349	2.82
.16	.400	.48	.63	.794	.95	1.40	1.183	1.42	2.40	1.549	1.86	3.81	1.952	2.34	5.56	2.358	2.83
.17	.412	.49	.64	.800	.96	1.42	1.192	1.43	2.43	1.559	1.87	3.84	1.960	2.35	5.60	2.366	2.84
.18	.424	.51	.65	.806	.97	1.44	1.200	1.44	2.46	1.568	1.88	3.87	1.967	2.36	5.64	2.375	2.85
.19	.436	.52	.66	.812	.97	1.46	1.208	1.45	2.49	1.578	1.89	3.90	1.975	2.37	5.68	2.383	2.86
.20	.447	.54	.67	.819	.98	1.48	1.217	1.46	2.52	1.587	1.90	3.93	1.982	2.38	5.72	2.392	2.87
.21	.458	.55	.68	.825	.99	1.50	1.225	1.47	2.55	1.597	1.92	3.96	1.990	2.39	5.76	2.400	2.88
.22	.469	.56	.69	.831	1.00	1.52	1.233	1.48	2.58	1.606	1.93	3.99	1.997	2.40	5.80	2.408	2.89
.23	.480	.58	.70	837	1.00	1.54	1.241	1.49	2.61	1.616	1.94	4.02	2.005	2.41	5.84	2.417	2.90
.24	.490	.59	.71	.843	1.01	1.56	1.249	1.50	2.64	1.625	1.95	4.05	2.012	2.41	5.88	2.425	2.91
.25	.500	.60	.72	.849	1.02	1.58	1.257	1.51	2.67	1.634	1.96	4.08	2.020	2.42	5.92	2.433	2.92
.26	.510	.61	.73	.854	1.02	1.60	1.265	1.52	2.70	1.643	1.97	4.11	2.027	2.43	5.96	2.441	2.93
.27	.520	.62	.74	.860	1.03	1.62	1.273	1.53	2.73	1.652	1.98	4.14	2.035	2.44	6.00	2.449	2.94
.28	.529	.63	.75	.866	1.04	1.64	1.281	1.54	2.76	1.661	1.99	4.17	2.042	2.45	6.04	2.458	2.95
.29	.539	.65	.76	.872	1.05	1.66	1.288	1.55	2.79	1.670	2.00	4.20	2.049	2.46	6.08	2.466	2.96
.30	.548	.66	.77	.877	1.05	1.68	1.296	1.56	2.82	1.679	2.01	4.23	2.057	2 47	6.12	2.474	2.97
.31	.557	.67	.78	.883	1.06	1.70	1.304	1.56	2.85	1.688	2.03	4.26	2.064	2.48	6.16	2.482	2.98
.32	.566	.68	.79	.889	1.07	1.72	1.311	1.57	2.88	1.697	2.04	4.32	2.078	2.49	6.20	2.490	2.99
.33	.574	.69	.80	.894	1.07	1.74	1.319	1.58	2.91	1.706	2.05	4.36	2.088	2.51	6.24	2.498	3.00
.34	.583	.70	.82	.906	1.09	1.76	1.327	1.59	2.94	1.715	2.06	4.40	2.098	2.52	6.28	2.506	3.01
.35	.592	.71	.84	.917	1.10	1.78	1.334	1.60	2.97	1.723	2.07	4.44	2.107	2.53	6.32	2.514	3.02
.36	.600	.72	.86	.927	1.11	1.80	1.342	1.61	3.00	1.732	2.08	4.48	2.117	2.54	6.36	2.522	3.03
.37	.608	.73	.88	.938	1.13	1.82	1.349	1.62	3.03	1.741	2.09	4.52	2.126	2.55	6.40	2.530	3.04
.38	.616	.74	.90	.949	1.14	1.84	1.356	1.63	3.06	1.749	2.10	4.56	2.135	2.56	6.44	2.538	3.05
.39	.624	.75	.92	.959	1.15	1.86	1.364	1.64	3.09	1.758	2.11	4.60	2.145	2.57	6.48	2.546	3.06
.40	.632	.76	.94	.970	1.16	1.88	1.371	1.65	3.12	1.766	2.12	4.64	2.154	2.58	6.52	2.553	3.06
.41	.640	.77	.96	.980	1.18	1.90	1.378	1.65	3.15	1.775	2.13	4.68	2.163	2.60	6.56	2.561	3.07
.42	.648	.78	.98	.990	1.19	1.92	1.386	1.66	3.18	1.783	2.14	4.72	2.173	2.61	6.60	2.569	3.08
.43	.656	.79	1.00	1.000	1.20	1.94	1.393	1.67	3.21	1.792	2.15	4.76	2.182	2.62	6.64	2.577	3.09
.44	.663	.80	1.02	1.010	1.21	1.96	1.400	1.68	3.24	1.800	2.16	4.80	2.191	2.63	6.68	2.585	3.10
.45	.671	.81	1.04	1.020	1.22	1.98	1.407	1.69	3.27	1.808	2.17	4.84	2.200	2.64	6.72	2.592	3.11
.46	.678	.81	1.06	1.030	1.24	2.00	1.414	1.70	3.30	1.817	2.18	4.88	2.209	2.65	6.76	2.600	3.12
.47	.686	.82	1.08	1.039	1.25	2.02	1.421	1.71	3.33	1.825	2.19	4.92	2.218	2 66	6.80	2.608	3.13
.48	.693	.83	1.10	1.049	1.26	2.04	1.428	1.71	3.36	1.833	2.20	4.96	2.227	2.67	6.84	2.615	3.14
.49	.700	.84	1.12	1.058	1.27	2.06	1.435	1.72	3.39	1.841	2.21	5.00	2.236	2.68	6.88	2.623	3.15
.50	.707	.85	1.14	1.068	1.28	2.08	1.442	1.73	3.42	1.849	2.22	5.04	2.245	2.69	6.92	2.631	3.16
.51	.714	.86	1.16	1.077	1.29	2.10	1.449	1.74	3.45	1.857	2.23	5.08	2.254	2.70	6.96	2.638	3.17
.52	.721	.87	1.18	1.086	1.30	2.12	1.456	1.75	3.48	1.865	2.24	5.12	2.263	2.72	7.00	2.646	3.17
.53	.718	.87	1.20	1.095	1.31	2.14	1.463	1.76	3.51	1.873	2.25	5.16	2.272	2.73	7.04	2.653	3.18
.54	.735	.88	1.22	1.105	1.33	2.16	1.470	1.76	3.54	1.881	2.26	5.20	2.280	2.74	7.08	2.661	3.19
.55	.742	.89	1.24	1.114	1.34	2.18	1.476	1.77	3.57	1.889	2.27	5.24	2.289	2.75	7.10	2.665	3.20
.56	.748	.90	1.26	1.122	1.35	2.20	1.483	1.78	3.60	1.897	2.28	5.28	2.298	2.76	7.15	2.674	3.21

This table used by permission of Draper Co., Hopedale, Mass.

bad. All of the pockets or open spaces around the lickerin must be gotten rid of so that every fibre which is fed in at the feed plate will go through; it must not stop and collect in bunches; if it does, there will be trouble somewhere. We see a card that seems to run well and to do good work, but frequently it will break down in front of the doffer, or at the coiler head. I have no doubt that there are many rooms that worry along in this condition and the carder thinks it is the nature of the thing and cannot be helped. The lickerin can cause all of this trouble as well as other parts of the card.

If the directions given above are strictly followed in the settings, we will have a card, so far as the lickerin is concerned, that will run day in and day out without the sliver breaking down in front of the doffer or at the coiler head, unless caused by piecing in lap. This part of the card is neglected more than any other piece of machinery in the mill, presumably on account of the dirt and dust, as it is somewhat unpleasant to crawl about under the card, especially when running. But it pays to bring the lickerin up to its highest efficiency. Get one right and then set all the rest like it. To do this properly we should have a gauge made with the angle just right. Place it on the card frame and have the blade to rest against the bracket that holds the knives. In this way we can get them all set alike. The settings given are for stock one inch long and under. The lickerin needs more attention, care, serious thought and study than some men give their room in a lifetime.

A few years ago it was impossible to take a line of ten or twelve cards and make them all do the same quality of work. Some would be cloudy with all we could do, or some would do better than others along the line. Every card seemed to be a machine peculiar to itself. But of late years the pieces are duplicates, every piece the same and fit on any card that is made by the same pattern, and it is but little trouble in a room of eighty or a hundred cards to have the sliver from every card to look the same. There is but one excuse and that is incompetency of the carder, and I will add laziness to his sin of omission.

Though it would not be expected for a carder to take a room that has been butchered up like some rooms are and make all of the cards do the same quality of carding.

Hank Roving	Square Root	Twist, 1.2 by Sq. R.
.10	.316	.38
.11	.332	.40
.12	.346	.41
.13	.361	.43
.14	.374	.45
.15	.387	.46
.16	.400	.48
.17	.412	.49
.18	.424	.51
.19	.436	.52
.20	.447	.54
.21	.458	.55
.22	.469	.56
.23	.480	.58
.24	.490	.59
.25	.500	.60
.26	.510	.61
.27	.520	.62
.28	.529	.63
.29	.539	.65
.30	.548	.66
.31	.557	.67
.32	.566	.68
.33	.574	.69
.34	.583	.70
.35	.592	.71
.36	.600	.72
.37	.608	.73
.38	.616	.74
.39	.624	.75
.40	.632	.76
.41	.640	.77
.42	.648	.78
.43	.656	.79
.44	.663	.80
.45	.671	.81
.46	.678	.81
.47	.686	.82
.48	.693	.83
.49	.700	.84
.50	.707	.85
.51	.714	.86
.52	.721	.87
.53	.718	.87
.54	.735	.88
.55	.742	.89
.56	.748	.90

This table us

TWIST OF ROVING

Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving	Square Root	Twist, 1.2 by Sq. R.
7.20	2.683	3.22	9.55	3.090	3.71	12.18	3.490	4.19	14.98	3.870	4.64	18.20	4.266	5.12	21.68	4.656	5.59
7.25	2.693	3.23	9.60	3.098	3.72	12.24	3.499	4.20	15.05	3.879	4.65	18.27	4.274	5.13	21.76	4.665	5.60
7.30	2.702	3.24	9.65	3.106	3.73	12.30	3.507	4.21	15.12	3.888	4.67	18.34	4.283	5.14	21.84	4.673	5.61
7.35	2.711	3.25	9.70	3.114	3.74	12.36	3.516	4.22	15.19	3.897	4.68	18.41	4.291	5.15	21.92	4.682	5.62
7.40	2.720	3.26	9.75	3.122	3.75	12.42	3.524	4.23	15.26	3.906	4.69	18.48	4.299	5.16	22.00	4.690	5.63
7.45	2.729	3.27	9.80	3.130	3.76	12.48	3.533	4.24	15.33	3.915	4.70	18.55	4.307	5.17	22.08	4.699	5.64
7.50	2.739	3.29	9.85	3.138	3.77	12.54	3.541	4.25	15.40	3.924	4.71	18.62	4.315	5.18	22.16	4.707	5.65
7.55	2.748	3.30	9.90	3.146	3.78	12.60	3.550	4.26	15.47	3.933	4.72	18.69	4.323	5.19	22.24	4.716	5.66
7.60	2.757	3.31	9.95	3.154	3.78	12.66	3.558	4.27	15.54	3.942	4.73	18.76	4.331	5.20	22.32	4.724	5.67
7.65	2.766	3.32	10.00	3.162	3.79	12.72	3.567	4.28	15.61	3.951	4 74	18.83	4.339	5.21	22.40	4.733	5.68
7.70	2.775	3.33	10.05	3.170	3.80	12.78	3.575	4.29	15.68	2.960	4.75	18.90	4.347	5.22	22.48	4.741	5.69
7.75	2.784	3.34	10.10	3.178	3.81	12.84	3.583	4.30	15.75	3.969	4.76	18.97	4.355	5.23	22.56	4.750	5.70
7.80	2.793	3.35	10.15	3.186	3.82	12.90	3.592	4.31	15.82	3.977	4.77	19.04	4.363	5.24	22.64	4.758	5.71
7.85	2.802	3.36	10.20	3.194	3.83	12.96	3.600	4.32	15.89	3.986	4.78	19.11	4.371	5.25	22.72	4.767	5.72
7.90	2.811	3.37	10.25	3.202	3.84	13.02	3.608	4.33	15.96	3.995	4.79	19.18	4.379	5.26	22.80	4.775	5.73
7.95	2.820	3.38	10.30	3.209	3.85	13.08	3.617	4.34	16.03	4.004	4.80	19.25	4.387	5.26	22.88	4.783	5.74
8.00	2.828	3.39	10.35	3.217	3.86	13.14	3.625	4.35	16.10	4.012	4.81	19.32	4.395	5.27	22.96	4.792	5.75
8.05	2.837	3.40	10.40	3.225	3.87	13.20	3.633	4.36	16.17	4.021	4.83	19.39	4.403	5.28	23.04	4.800	5.76
8.10	2.846	3.42	10.45	3.233	3.88	13.26	3.641	4.37	16.24	4.030	4.84	19.46	4.411	5.29	23.12	4.808	5.77
8.15	2.855	3.43	10.50	3.240	3.89	13.32	3.650	4.38	16.31	4.039	4.85	19.53	4.419	5.30	23.20	4.817	5.78
8.20	2.864	3.44	10.55	3.248	3.90	13.38	3.658	4.39	16.38	4.047	4.86	19.60	4.427	5.31	23.28	4.825	5.79
8.25	2.872	3.45	10.62	3.259	3.91	13.44	3.666	4.40	16.45	4.056	4.87	19.67	4.435	5.32	23.36	4.833	5.80
8.30	2.881	3.46	10.68	3.268	3.92	13.50	3.674	4.41	16.52	4.064	4.88	19.76	4 445	5.33	23.44	4.841	5.81
8.35	2.890	3.47	10.74	3.277	3.93	13.56	3.682	4 42	16.59	4.073	4.89	19.84	4.454	5.34	23.52	4.850	5.82
8.40	2.898	3.48	10.80	3.286	3.94	13.62	3.691	4.43	16.66	4.082	4.90	19.92	4.463	5.36	23.60	4.858	5.83
8.45	2.907	3.49	10.86	3.295	3.95	13.68	3.699	4.44	16.73	4.090	4.91	20.00	4.472	5.37	23.68	4.866	5.84
8.50	2.915	3.50	10.92	3.305	3.97	13.74	3.707	4.45	16.80	4.099	4 92	20.08	4.481	5.38	23.76	4.874	5.85
8.55	2.924	3.51	10.98	3.314	3.98	13.80	3.715	4.46	16.87	4.107	4.93	20.16	4.490	5.39	23.84	4.883	5.86
8.60	2.933	3.52	11.04	3.323	3.99	13.86	3.723	4.47	16.94	4.116	4.94	20.24	4.499	5.40	23.92	4.891	5.87
8.65	2.911	3.53	11.10	3.332	4.00	13.92	3 731	4.48	17.01	4.124	4.95	20.32	4.508	5.41	24.00	4.899	5.88
8.70	2.950	3.54	11.16	3.341	4.01	13.98	3.739	4.49	17.08	4.133	4.96	20.40	4.517	5.42	24.08	4.907	5.89
8.75	2.958	3.55	11.22	3.350	4.02	14.04	3.747	4.50	17.15	4.141	4.97	20.48	4.525	5.43	24.16	4.915	5.90
8.80	2.966	3.56	11.28	3.359	4.03	14.10	3.755	4.51	17.22	4.150	4.98	20.56	4.534	5.44	24.24	4.923	5.91
8.85	2.975	3.57	11.34	3.367	4.04	14.16	3.763	4.52	17.29	4.158	4.99	20.64	4.543	5.45	24.32	4.932	5.92
8.90	2.983	3.58	11.40	3.376	4.05	14.22	3.771	4.53	17.36	4.167	5.00	20.72	4.552	5.46	24.40	4.940	5.93
8.95	2.992	3.59	11.46	3.385	4.06	14.28	3.779	4.53	17.43	4.175	5.01	20.80	4.561	5.47	24.48	4.948	5.94
9.09	3.000	3.60	11.52	3.394	4.07	14.34	3.787	4.54	17.50	4 183	5.02	20.88	4.569	5.48	24.56	4.956	5.95
9.05	3.008	3.61	11.58	3.403	4.08	14.40	3 795	4.55	17.57	4.192	5.03	20.96	4.578	5.49	24.64	4.964	5.96
9.10	3.017	3.62	11.64	3.412	4.09	14.46	3.803	4.56	17.64	4.200	5.04	21.04	4.587	5.50	24.72	4.972	5.97
9.15	3.025	3.63	11.70	3.421	4.11	14.52	3.811	4.57	17.71	4.208	5.05	21.12	4.596	5.52	24.80	4.980	5.98
9.20	3.033	3.64	11.76	3.429	4.11	14.58	3.818	4.58	17.78	4.217	5.06	21.20	4.604	5.52	24.88	4.988	5.99
9.25	3.041	3.65	11.82	3.438	4.13	14.64	3.826	4.59	17.85	4.225	5.07	21.28	4.613	5.54	24.96	4.996	6.00
9.30	3.050	3.66	11.88	3.447	4.14	14.70	3.834	4.60	17.92	4.233	5.08	21.36	4.622	5.55	25.04	5.004	6.00
9.35	3.058	3.67	11.94	3.455	4.15	14.76	3.842	4.61	17.99	4.241	5.09	21.44	4.630	5.56	25.12	5.012	6.01
9.40	3.066	3.68	12.00	3.464	4.16	14.84	3.852	4.62	18.06	4.250	5.10	21.52	4.639	5.57	25.20	5.020	6.02
9.45	3.074	3.69	12.06	3.473	4.17	14.91	3.861	4 63	18.13	4.258	5.11	21.60	4.648	5.58	25.28	5.028	6.03
9.50	3.082	3.70	12.12	2.481	4.18												

This table used by permission of Draper Co., Hopedale, Mass.

Hank Roving	Square Root	Twist, 1.2 by Sq. R.	Hank Roving
7.20	2.683	3.22	9.5
7.25	2.693	3.23	9.6
7.30	2.702	3.24	9.6
7.35	2.711	3.25	9.7
7.40	2.720	3.26	9.7
7.45	2.729	3.27	9.8
7.50	2.739	3.29	9.8
7.55	2.748	3.30	9.9
7.60	2.757	3.31	9.9
7.65	2.766	3.32	10.0
7.70	2.775	3.33	10.0
7.75	2.784	3.34	10.1
7.80	2.793	3.35	10.1
7.85	2.802	3.36	10.2
7.90	2.811	3.37	10.2
7.95	2.820	3.38	10.3
8.00	2.828	3.39	10.3
8.05	2.837	3.40	10.4
8.10	2.846	3.42	10.4
8.15	2.855	3.43	10.5
8.20	2.864	3.44	10.5
8.25	2.872	3.45	10.6
8.30	2.881	3.46	10.6
8.35	2.890	3.47	10.7
8.40	2.898	3.48	10.8
8.45	2.907	3.49	10.8
8.50	2.915	3.50	10.9
8.55	2.924	3.51	10.9
8.60	2.933	3.52	11.0
8.65	2.941	3.53	11.1
8.70	2.950	3.54	11.1
8.75	2.958	3.55	11.2
8.80	2.966	3.56	11.2
8.85	2.975	3.57	11.3
8.90	2.983	3.58	11.4
8.95	2.992	3.59	11.4
9.00	3.000	3.60	11.5
9.05	3.008	3.61	11.5
9.10	3.017	3.62	11.6
9.15	3.025	3.63	11.7
9.20	3.033	3.64	11.7
9.25	3.041	3.65	11.8
9.30	3.050	3.66	11.8
9.35	3.058	3.67	11.9
9.40	3.066	3.68	12.0
9.45	3.074	3.69	12.0
9.50	3.082	3.70	12.1

This table used by per

TABLE FOR NUMBERING ROVING BY GRAINS

Number of Roving	Grains per Yard	Grains per Hank	Number of Roving	Grains per Yard	Grains per Hank
.10	83.33	70000.	3¼	2.56	2153.
.15	55.56	46666.	3½	2.38	2000.
.20	41.66	35000.	3¾	2.22	1866.
.30	27.77	23333.	4	2.08	1750.
.40	20.83	17500.	4¼	1.96	1647.
.50	16.66	14000.	4½	1.85	1555.
.60	13.88	11666.	4¾	1.75	1473.
.70	11.90	10000.	5	1.66	1400.
.80	10.41	8750.	5¼	1.580	1333.
.90	9.25	7777.	5½	1.510	1272.
1.00	8.33	7000.	5¾	1.440	1217.
1.10	7.57	6363.	6	1.380	1166.
1.20	6.94	5833.	6¼	1.330	1120.
1.30	6.41	5384.	6½	1.280	1076.
1.40	5.95	5000.	6¾	1.234	1037.
1.50	5.55	4666.	7	1.190	1000.
1.60	5.20	4375.	7¼	1.149	965.50
1.70	4.90	4117.	7½	1.111	933.30
1.80	4.62	3888.	7¾	1.075	903.20
1.90	4.38	3684.	8	1.041	875.00
2.00	4.16	3500.	8¼	1.010	848.40
2¼	3.70	3111.	8½	.980	823.50
2½	3,33	2800.	8¾	.952	800.00
2¾	3.03	2545.	9	.925	777.77
3	2.77	2433.			

TABLE FOR NUMBERING ROVING

Weight of 12 Yds., Grains	Hank Roving	Weight of 12 Yds., Grains	Hank Roving	Weight of 12 Yds., Grains	Hank Roving	Weight of 12 Yds., Grains	Hank Roving	Weight of 12 Yds., Grains	Hank Roving	Weight of 12 Yds., Grains	Hank Roving	Weight of 12 Yds., Grains	Hank Roving
1.	100.00	7.	14.29	12.	8.33	17.	5.88	22.	4.55	27.	3.70	32.	3.12
1.2	83.33	7.1	14.08	12.1	8.26	17.1	5.85	22.1	4.52	27.1	3.69	32.1	3.12
1.4	71.43	7.2	13.89	12.2	8.20	17.2	5.81	22.2	4.50	27.2	3.68	32.2	3.11
1.6	62.50	7.3	13.70	12.3	8.13	17.3	5.78	22.3	4.48	27.3	3.66	32.3	3.10
1.8	55.56	7.4	13.51	12.4	8.06	17.4	5.75	22.4	4.46	27.4	3.65	32.4	3.09
2.	50.00	7.5	13.33	12.5	8.00	17.5	5.71	22.5	4.44	27.5	3.64	32.5	3.08
2.2	45.45	7.6	13 16	12.6	7.94	17.6	5.68	22.6	4.42	27.6	3.62	32.6	3.07
2.4	41.67	7.7	12.99	12.7	7.87	17.7	5.65	22.7	4.41	27.7	3.61	32.7	3.06
2.6	38.46	7.8	12.82	12.8	7.81	17.8	5.62	22.8	4.39	27.8	3.60	32.8	3.05
2.8	35.71	7.9	12.66	12.9	7.75	17.9	5.59	22.9	4.37	27.9	3.58	32.9	3.04
3.	33.33	8.	12.50	13.	7.69	18.	5.56	23.	4.35	28.	3.57	33.	3.03
3.1	32.26	8.1	12.35	13.1	7.63	18.1	5.52	23.1	4.33	28.1	3.56	33.1	3.02
3.2	31.25	8.2	12.20	13.2	7.58	18.2	5.49	23.2	4.31	28.2	3.55	33.2	3.01
3:3	30.30	8.3	12.05	13.3	7.52	18.3	5.46	23.3	4.29	28.3	3.53	33.3	3.00
3.4	29.41	8.4	11.90	13.4	7.46	18.4	5.43	23.4	4.27	28.4	3.52	33.4	2.99
3.5	28.57	8.5	11.76	13.5	7.41	18.5	5.41	23.5	4.26	28 5	3.51	33.5	2.99
3.6	27.78	8.6	11.63	13.6	7.35	18.6	5.38	23.6	4.24	28.6	3.50	33.6	2.98
3.7	27.03	8.7	11.49	13.7	7.30	18.7	5.35	23.7	4.22	28.7	3.49	33.7	2.97
3.8	26.32	8.8	11.36	13.8	7.25	18.8	5.32	23.8	4.20	28.8	3.47	43.8	2.96
3.9	25.64	8.9	11.24	13.9	7.19	18.9	5.29	23.9	4.18	28.9	3.46	33.6	2.95
4.	25.00	9.	11.11	14.	7.14	19.	5.26	24.	4.17	29.	3.45	34.	2.94
4.1	24.39	9.1	10.99	14.1	7.09	19.1	5.24	24.1	4.15	29.1	3.44	34.1	2.93
4.2	23.81	9.2	10.87	14.2	7.04	19.2	5.21	24.2	4.13	29.2	3.42	34.2	2.92
4.3	23.26	9.3	10.75	14.3	6.99	19.3	5.18	24.3	4.12	29.3	3.41	34.3	2.92
4.4	22.73	9.4	10.64	14.4	6.94	19.4	5.15	24.4	4.10	29.4	3.40	34.4	2.91
4.5	22.22	9.5	10.53	14.5	6.90	19.5	5.13	24.5	4.08	29.2	3.39	34.5	2.90
4.6	21.74	9.6	10 42	14.6	6.85	19.6	5.10	24.6	4.07	29.6	3.38	34.6	2.89
4.7	21.28	9.7	10.31	14.7	6.80	19.7	5.08	24.7	4.05	29.7	3.37	34.7	2.88
4.8	20.83	9.8	10.20	14.8	6.76	19.8	5.05	24.8	4.03	29.8	3.36	34.8	2.87
4.9	20.41	9.9	10.10	14.9	6.71	19.9	5.03	24.9	4.02	29.9	3.34	34.9	2.87
5.	20.00	10.	10.00	15.	6.67	20.	5.00	25.	4.00	30.	3.33	35.	2.86
5.1	19.61	10.1	9.90	15.1	6.62	20.1	4.98	25.1	3.98	30.1	3.32	35.1	2.85
5.2	19.23	10.2	9.80	15.2	6.58	20.2	4.95	25.2	3.97	30.2	3.31	35.2	2.84
5.3	18.87	10.3	9.71	15.3	6.54	20.3	4.93	25.3	3.95	30.3	3.30	35.3	2.83
5.4	18.52	10.4	9.62	15.4	6.49	20.4	4.90	25.4	3.94	30.4	3.29	35.4	2.82
5.5	18.18	10.5	9.52	15.5	6.45	20.5	4.88	25.5	3.92	30.5	3.28	35.5	2.82
5.6	17.86	10.6	9.43	15.6	6.41	20.6	4.85	25.6	3.91	30.6	3.27	35.6	2.81
5.7	17.54	10.7	9.35	15.7	6.37	20.7	4.83	25.7	3.89	30.7	3.26	35.7	2.80
5.8	17.24	10.8	9.26	15.8	6.33	20.8	4.81	25.8	3.88	30.8	3.25	35.8	2.79
5.9	16.95	10.9	9.17	15.9	6.29	20.9	4.78	25.9	3.86	30.9	3.24	35.9	2.79
6.	16.67	11.	9.09	16.	6.25	21.	4.76	26.	3.85	31.	3.23	36.	2.78
6.1	16.36	11.1	9.01	16.1	6.21	21.1	4.74	26.1	3.83	31.1	3.22	36.1	2.77
6.2	16.13	11.2	8.93	16.2	6.17	21.2	4.72	26.2	3.82	31.2	3.21	36.2	2.76
6.3	15.87	11.3	8.85	16.3	6.13	21.3	4.69	26.3	3.80	31.3	3.19	36.3	2.75
6.4	15.62	11.4	8.77	16.4	6.10	21.4	4.67	26.4	8.79	31.4	3.18	36.4	2.75
6.5	15.38	11.5	8.70	16.5	6.06	21.5	4.65	26.5	3.77	31.5	3.17	36.5	2.74
6.6	15.15	11.6	8.62	16.6	6.02	21.6	4.63	26.6	3.76	31.6	3.16	36.6	2.73
6.7	14.93	11.7	8.55	16.7	5.99	21.7	4.61	26.7	3.75	31.7	3.15	36.7	2.72
6.8	14.71	11.8	8.47	16.8	5.95	21.8	4.59	26.8	3.73	31.8	3.14	36.8	2.72
6.9	14.49	11.9	8.40	16.9	5.92	21.9	4.57	26.9	3.72	31.9	3.13	36.9	2.71

This table used by permission of Draper Co., Hopedale, Mass.

JUN 13 1905

RAY PRINTING CO.
CHARLOTTE, N. C.